



Building knowledge

Job Order Contract Technical Specifications

Book 1 CSI Divisions 01 - 33 December 2020

City Colleges of Chicago
Low Voltage



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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 53 16 00	01 22 16 00	No Specification Required

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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 55 26 00	01 22 16 00	No Specification Required
01 56 26 00	01 22 16 00	No Specification Required
01 56 29 00	01 22 16 00	No Specification Required
01 56 39 00	01 22 16 00	No Specification Required
01 66 19 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 02 41 13 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 13 13

SECTION 02 41 13 13a - 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 13a

SECTION 02 41 19 13 - 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 02 41 19 13

SECTION 02 41 19 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 19 13a

Task	Specification	Specification Description
02 41 19 13	02 41 13 13	Selective Demolition
02 41 19 13	02 41 13 13a	Portland Cement Concrete Removal
02 41 19 16	02 41 13 13	Selective Demolition
02 42 21 47	02 41 13 13	Selective Demolition

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SECTION 03 05 13 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 silicate 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 silicate 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 silicate 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, restraighening, 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 restraighening 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 do 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 13 00

Task	Specification	Specification Description
03 11 13 00	01 22 16 00	No Specification Required
03 11 13 00	03 05 13 00	Cast-In-Place Concrete
03 15 16 00	03 05 13 00	Cast-In-Place Concrete
03 15 19 00	05 50 00 00	Metal Fabrications
03 21 11 00	03 05 13 00	Cast-In-Place Concrete
03 21 16 00	03 05 13 00	Cast-In-Place Concrete
03 22 11 00	03 05 13 00	Cast-In-Place Concrete
03 22 13 00	03 05 13 00	Cast-In-Place Concrete
03 22 16 00	03 05 13 00	Cast-In-Place Concrete
03 30 53 00	03 05 13 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: **As 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 directed**, percent plus or minus 1.5 percent for **1-inch (25-mm)** nominal maximum aggregate size.
 - c. Air Content: **6 OR 5 OR 3-1/2, as directed**, percent plus or minus 1.5 percent for **3/4-inch (19-mm)** nominal maximum aggregate size.
4. Limit water-soluble, chloride-ion content in hardened concrete to **0.15 OR 0.30, as directed**, percent by weight of cement.
5. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 - a. Use water-reducing admixture **OR** 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. Nonagitator 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 nonagitator 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 exceeding 75 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 13 00	Cast-In-Place Concrete
03 35 13 00	03 05 13 00	Cast-In-Place Concrete
03 35 16 00	03 05 13 00	Cast-In-Place Concrete
03 35 19 00	03 05 13 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 12 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 13 00	Cast-In-Place Concrete
03 35 26 00	03 05 13 00	Cast-In-Place Concrete
03 35 29 00	03 05 13 00	Cast-In-Place Concrete
03 35 33 00	03 05 13 00	Cast-In-Place Concrete
03 35 63 00	03 05 13 00	Cast-In-Place Concrete
03 35 83 00	03 05 13 00	Cast-In-Place Concrete
03 37 16 00	03 05 13 00	Cast-In-Place Concrete

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SECTION 03 39 13 00 - 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 39 13 00

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Task	Specification	Specification Description
03 39 23 23	03 05 13 00	Cast-In-Place Concrete
03 61 16 00	01 22 16 00	No Specification Required

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SECTION 03 62 13 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 attack.
 - 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 62 13 00

Task	Specification	Specification Description
03 62 16 00	03 62 13 00	Plant-Precast Structural Concrete
03 64 23 00	03 62 13 00	Plant-Precast Structural Concrete
03 64 26 00	01 22 16 00	No Specification Required

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Task	Specification	Specification Description
04 05 16 26	01 54 23 00a	Unit Masonry Assemblies

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Task	Specification	Specification Description
05 05 19 00	05 50 00 00	Metal Fabrications

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SECTION 05 05 21 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.

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Task	Specification	Specification Description
05 05 23 00	05 05 21 00	Structural Steel
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 1/360 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 21 00	Structural Steel
05 12 23 00	05 50 00 00	Metal Fabrications

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SECTION 05 31 13 00 - STEEL DECK

1.1 GENERAL

A. Description Of Work

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

B. Summary

1. This Section includes the following:
 - a. Roof deck.
 - b. Acoustical roof deck.
 - c. Cellular roof deck.
 - d. Acoustical cellular roof deck.
 - e. Composite floor deck.
 - f. Electrified cellular floor deck.
 - g. Noncomposite form deck.
 - h. Noncomposite vented form deck.

C. Submittals

1. Product Data: For each type of deck, accessory, and product indicated.
2. LEED Submittal:
 - a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - 1) Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.
4. Product Certificates.
5. Welding certificates.
6. Field quality-control test and inspection reports.
7. Research/Evaluation Reports: For steel deck.

D. Quality Assurance

1. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."
2. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
 - a. Fire-Resistance Ratings: Indicated by design designations of applicable testing and inspecting agency.
 - b. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.
3. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
4. Electrical Raceway Units: Provide UL-labeled cellular floor-deck units complying with UL 209 and listed in UL's "Electrical Construction Equipment Directory" for use with standard header ducts and outlets for electrical distribution systems.
5. FMG Listing: Provide steel roof deck evaluated by FMG and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

6. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

E. Delivery, Storage, And Handling

1. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
2. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
 - a. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

1.2 PRODUCTS

A. Roof Deck

- a. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:
- b. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade **33 (230)** **OR 40 (275)** **OR 80 (550)**, **as directed**, minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
 - 1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
- c. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade **33 (230)** **OR 40 (275)** **OR 80 (550)**, **as directed**, **G60 (Z180)** **OR G90 (Z275)**, **as directed**, zinc coating.
- d. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade **33 (230)** **OR 40 (275)** **OR 80 (550)**, **as directed**, **G60 (Z180)** zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
 - 1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
- e. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Structural Steel (SS), Grade **33 (230)** minimum, **AZ50 (AZ150)** aluminum-zinc alloy coating.
- f. Deck Profile: As indicated **OR** Type NR, narrow rib **OR** Type IR, intermediate rib **OR** Type WR, wide rib **OR** Type 3DR, deep rib **OR** Long span, **as directed**.
- g. Cellular Deck Profile: As indicated **OR** Type WR, wide rib **OR** Type 3DR, deep rib **OR** Long span, **as directed**, with bottom plate.
- h. Profile Depth: As indicated **OR 1-1/2 inches (38 mm)** **OR 2 inches (51 mm)** **OR 3 inches (76 mm)** **OR 4-1/2 inches (114 mm)** **OR 6 inches (152 mm)** **OR 7-1/2 inches (190 mm)**, **as directed**.
- i. Design Uncoated-Steel Thickness: As indicated **OR 0.0295 inch (0.75 mm)** **OR 0.0358 inch (0.91 mm)** **OR 0.0474 inch (1.20 mm)** **OR 0.0598 inch (1.52 mm)** **OR 0.0747 inch (1.90 mm)**, **as directed**.
- j. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated **OR 0.0358/0.0358 inch (0.91/0.91 mm)** **OR 0.0358/0.0474 inch (0.91/1.20 mm)** **OR 0.0474/0.0474 inch (1.20/1.20 mm)** **OR 0.0474/0.0598 inch (1.20/1.52 mm)** **OR 0.0598/0.0474 inch (1.52/1.20 mm)** **OR 0.0598/0.0598 inch (1.52/1.52 mm)**, **as directed**.
- k. Span Condition: As indicated **OR** Simple span **OR** Double span **OR** Triple span or more, **as directed**.
- l. Side Laps: Overlapped **OR** Interlocking seam, **as directed**.

B. Acoustical Roof Deck

1. Acoustical Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:

- a. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade **33 (230) OR 40 (275) OR 80 (550)**, **as directed**, minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
 - 1) Color: Manufacturer's standard **OR Gray OR White OR Gray** top surface with white underside, **as directed**.
- b. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade **33 (230) OR 40 (275) OR 80 (550)**, **as directed**, **G60 (Z180) OR G90 (Z275)**, **as directed**, zinc coating.
- c. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade **33 (230) OR 40 (275) OR 80 (550)**, **as directed**, **G60 (Z180)** zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
 - 1) Color: Manufacturer's standard **OR Gray OR White OR Gray** top surface with white underside, **as directed**.
- d. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Structural Steel (SS), Grade **33 (230)** minimum, **AZ50 (AZ150)** aluminum-zinc alloy coating.
- e. Deck Profile: As indicated **OR Type WR, wide rib OR Type 3DR, deep rib OR Long span**, **as directed**.
- f. Cellular Deck Profile: As indicated **OR Type WR, wide rib OR Type 3DR, deep rib OR Long span**, **as directed**, with bottom plate.
- g. Profile Depth: As indicated **OR 1-1/2 inches (38 mm) OR 2 inches (51 mm) OR 3 inches (76 mm) OR 4-1/2 inches (114 mm) OR 6 inches (152 mm) OR 7-1/2 inches (190 mm)**, **as directed**.
- h. Design Uncoated-Steel Thickness: As indicated **OR 0.0295 inch (0.75 mm) OR 0.0358 inch (0.91 mm) OR 0.0474 inch (1.20 mm) OR 0.0598 inch (1.52 mm)**, **as directed**.
- i. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated **OR 0.0358/0.0358 inch (0.91/0.91 mm) OR 0.0358/0.0474 inch (0.91/1.20 mm) OR 0.0474/0.0358 inch (1.20/0.91 mm) OR 0.0474/0.0474 inch (1.20/1.20 mm) OR 0.0474/0.0598 inch (1.20/1.52 mm) OR 0.0598/0.0474 inch (1.52/1.20 mm) OR 0.0598/0.0598 inch (1.52/1.52 mm)**, **as directed**.
- j. Span Condition: As indicated **OR Simple span OR Double span OR Triple span or more**, **as directed**.
- k. Side Laps: Overlapped **OR Interlocking seam**, **as directed**.
- l. Acoustical Perforations: Deck units with manufacturer's standard perforated vertical webs **OR Cellular deck units with manufacturer's standard perforated flat-bottom plate welded to ribbed deck**, **as directed**.
- m. Sound-Absorbing Insulation: Manufacturer's standard premolded roll or strip of glass or mineral fiber.
 - 1) Factory install sound-absorbing insulation into cells of cellular deck.
 - 2) Installation of sound-absorbing insulation is specified in Division 07.
- n. Acoustical Performance: NRC 0.65 **OR 0.75 OR 0.80 OR 0.85 OR 0.90**, **as directed**, tested according to ASTM C 423.

C. Composite Floor Deck

1. Composite Steel Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with the following:
 - a. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade **33 (230) OR 40 (275) OR 80 (550)**, **as directed**, minimum, with top surface phosphatized and unpainted and underside surface shop primed with manufacturers' standard gray **OR white**, **as directed**, baked-on, rust-inhibitive primer.
 - b. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade **33 (230)**, **G30 (Z90) OR G60 (Z180) OR G90 (Z275)**, **as directed**, zinc coating.
 - c. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade **33 (230)**, **G30 (Z90) OR G60 (Z180)**, **as directed**, zinc coating; with unpainted top surface and cleaned and pretreated bottom surface primed with manufacturer's standard gray **OR white**, **as directed**, baked-on, rust-inhibitive primer.

- d. Profile Depth: **1-1/2 inches (38 mm) OR 2 inches (51 mm) OR 3 inches (76 mm) OR** As indicated, **as directed**.
- e. Design Uncoated-Steel Thickness: **0.0295 inch (0.75 mm) OR 0.0358 inch (0.91 mm) OR 0.0474 inch (1.20 mm) OR 0.0598 inch (1.52 mm), as directed**.
- f. Span Condition: As indicated **OR** Simple span **OR** Double span **OR** Triple span or more, **as directed**.

D. Electrified Cellular Floor Deck

1. Electrified Cellular Floor Deck: Fabricate steel sheet cellular floor-deck panels, consisting of a ribbed top section welded to a lower flat-bottom sheet with interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck" in SDI Publication No. 30. Fabricate deck to the minimum section properties, width of panel, number and area of cells per panel indicated, and the following:
 - a. Cellular Deck Type: Composite **OR** Noncomposite, **as directed**.
 - b. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade **33 (230), G60 (Z180) OR G90 (Z275), as directed**, zinc coating.
 - c. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade **33 (230), G60 (Z180)** zinc coating; with underside surface cleaned, pretreated, and primed with manufacturer's standard gray **OR** white, **as directed**, baked-on, rust-inhibitive primer.
 - d. Profile Depth: **1-1/2 inches (38 mm) OR 2 inches (51 mm) OR 3 inches (76 mm) OR** As indicated, **as directed**.
 - e. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: **0.0358/0.0358 inch (0.91/0.91 mm) OR 0.0358/0.0474 inch (0.91/1.20 mm) OR 0.0358/0.0598 inch (0.91/1.52 mm) OR 0.0474/0.0358 inch (1.20/0.91 mm) OR 0.0474/0.0474 inch (1.20/1.20 mm) OR 0.0474/0.0598 inch (1.20/1.52 mm) OR 0.0598/0.0474 inch (1.52/1.20 mm) OR 0.0598/0.0598 inch (1.52/1.52 mm), as directed**.
 - f. Span Condition: As indicated **OR** Simple span **OR** Double span **OR** Triple span or more, **as directed**.
 - g. Factory punch holes, of size and arrangement indicated, into each deck cell at preset inserts and header duct locations.

E. Noncomposite Form Deck

1. Noncomposite Steel Form Deck: Fabricate ribbed-steel sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Noncomposite Steel Form Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with the following:
 - a. Uncoated Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade **33 (230) OR 40 (275) OR 80 (550), as directed**, minimum.
 - b. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade **33 (230) OR 40 (275) OR 80 (550), as directed**, minimum, with underside **OR** top and underside, **as directed**, surface shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
 - 1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
 - c. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade **33 (230) OR 40 (275) OR 80 (550), as directed, G30 (Z90) OR G60 (Z180) OR G90 (Z275), as directed**, zinc coating.
 - d. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade **33 (230) OR 80 (550), as directed, G60 (Z180)** zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
 - 1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
 - e. Profile Depth: **9/16 inch (14 mm) OR 15/16 inch (24 mm) OR 1-5/16 inches (33 mm) OR 1-1/2 inches (38 mm), as directed**.

- f. Design Uncoated-Steel Thickness: **0.0149 inch (0.38 mm) OR 0.0179 inch (0.45 mm) OR 0.0239 inch (0.61 mm) OR 0.0295 inch (0.75 mm) OR 0.0358 inch (0.91 mm) OR 0.0474 inch (1.20 mm) OR 0.0598 inch (1.52 mm), as directed.**
 - g. Span Condition: As indicated **OR** Simple span **OR** Double span **OR** Triple span or more, **as directed.**
 - h. Side Laps: Overlapped **OR** Interlocking seam, **as directed.**
- F. Noncomposite Vented Form Deck
1. Noncomposite Vented Steel Form Deck: Fabricate ribbed- and vented-steel sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Noncomposite Steel Form Deck," in SDI Publication No. 30, and with the following:
 - a. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade **33 (230) OR 40 (275) OR 80 (550), as directed, G30 (Z90) OR G60 (Z180) OR G90 (Z275), as directed,** zinc coating.
 - b. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade **33 (230) OR 80 (550), as directed, G30 (Z90) OR G60 (Z180), as directed,** zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
 - 1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed.**
 - c. Profile Depth: **9/16 inch (14 mm) OR 15/16 inch (24 mm) OR 1-5/16 inches (33 mm) OR 1-1/2 inches (38 mm), as directed.**
 - d. Design Uncoated-Steel Thickness: **0.0149 inch (0.38 mm) OR 0.0179 inch (0.45 mm) OR 0.0239 inch (0.61 mm) OR 0.0295 inch (0.75 mm) OR 0.0358 inch (0.91 mm) OR 0.0474 inch (1.20 mm) OR 0.0598 inch (1.52 mm), as directed.**
 - e. Span Condition: As indicated **OR** Simple span **OR** Double span **OR** Triple span or more, **as directed.**
 - f. Side Laps: Overlapped **OR** Interlocking seam, **as directed.**
 - g. Vent Slot Area: Manufacturer's standard vent slots providing 1-1/2 percent open area.
- G. Accessories
1. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
 2. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
 3. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, **No. 10 (4.8-mm)** minimum diameter.
 4. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
 5. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of **33,000 psi (230 MPa)**, not less than **0.0359-inch (0.91-mm)** design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
 6. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of **33,000 psi (230 MPa)**, of same material and finish as deck, and of thickness and profile indicated **OR** recommended by SDI Publication No. 30 for overhang and slab depth, **as directed.**
 7. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.
 8. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
 9. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, **0.0598 inch (1.52 mm) OR 0.0747 inch (1.90 mm), as directed,** thick, with factory-punched hole of **3/8-inch (9.5-mm)** minimum diameter.
 10. Recessed Sump Pans: Single-piece steel sheet, **0.0747 inch (1.90 mm)** thick, of same material and finish as deck, with **3-inch- (76-mm-)** wide flanges and level **OR** sloped, **as directed,** recessed pans of **1-1/2-inch (38-mm)** minimum depth. For drains, cut holes in the field.
 11. Flat Sump Plate: Single-piece steel sheet, **0.0747 inch (1.90 mm)** thick, of same material and finish as deck. For drains, cut holes in the field.

12. Galvanizing Repair Paint: ASTM A 780 **OR** SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight, **as directed**.
13. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

1.3 EXECUTION

A. Installation, General

1. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.
2. Install temporary shoring before placing deck panels, if required to meet deflection limitations.
3. Locate deck bundles to prevent overloading of supporting members.
4. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
 - a. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.
5. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
6. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
7. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
8. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
9. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

B. Roof-Deck Installation

1. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than **1-1/2 inches (38 mm)** long, and as follows:
 - a. Weld Diameter: **5/8 inch (16 mm) OR 3/4 inch (19 mm), as directed**, nominal.
 - b. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds **18 inches (450 mm)** apart, maximum **OR 12 inches (305 mm)** apart in the field of roof and **6 inches (150 mm)** apart in roof corners and perimeter, based on roof-area definitions in FMG Loss Prevention Data Sheet 1-28 **OR** as indicated, **as directed**.
 - c. Weld Washers: Install weld washers at each weld location.
2. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or **18 inches (450 mm) OR 36 inches (910 mm), as directed**, and as follows:
 - a. Mechanically fasten with self-drilling, **No. 10 (4.8-mm-)** diameter or larger, carbon-steel screws.
 - b. Mechanically clinch or button punch.
 - c. Fasten with a minimum of **1-1/2-inch- (38-mm-)** long welds.
3. End Bearing: Install deck ends over supporting frame with a minimum end bearing of **1-1/2 inches (38 mm)**, with end joints as follows:
 - a. End Joints: Lapped **2 inches (51 mm)** minimum **OR** Butted **OR** Lapped **2 inches (51 mm)** minimum or butted at Contractor's option, **as directed**.
4. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld **OR** mechanically fasten, **as directed**, flanges to top of deck. Space welds **OR** mechanical fasteners, **as directed**, not more than **12 inches (305 mm)** apart with at least one weld **OR** fastener, **as directed**, at each corner.
 - a. Install reinforcing channels or zees in ribs to span between supports and weld **OR** mechanically fasten, **as directed**.

5. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld **OR** Mechanically fasten, **as directed**, to substrate to provide a complete deck installation.
 - a. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.
 6. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.
 7. Sound-Absorbing Insulation: Installation into topside ribs of deck as specified in Division 07.
- C. Floor-Deck Installation
1. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
 - a. Weld Diameter: **5/8 inch (16 mm) OR 3/4 inch (19 mm), as directed**, nominal.
 - b. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of **12 inches (305 mm)** apart, but not more than **18 inches (457 mm)** apart.
OR
Weld Spacing: Space and locate welds as indicated.
 - c. Weld Washers: Install weld washers at each weld location.
 2. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or **36 inches (910 mm)**, and as follows:
 - a. Mechanically fasten with self-drilling, **No. 10 (4.8-mm-)** diameter or larger, carbon-steel screws.
 - b. Mechanically clinch or button punch.
 - c. Fasten with a minimum of **1-1/2-inch- (38-mm-)** long welds.
 3. End Bearing: Install deck ends over supporting frame with a minimum end bearing of **1-1/2 inches (38 mm)**, with end joints as follows:
 - a. End Joints: Lapped **OR Butted, as directed**.
 4. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.
 5. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.
 6. Electrified Cellular Floor Deck: Install cellular floor system with deck assembled from all-cellular units **OR** alternating cellular units with noncellular composite units **OR** units indicated, **as directed**.
 7. Install piercing hanger tabs at **14 inches (355 mm)** apart in both directions, within **9 inches (228 mm)** of walls at ends, and not more than **12 inches (305 mm)** from walls at sides, unless otherwise indicated.
- D. Field Quality Control
1. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
 2. Field welds will be subject to inspection.
 3. Testing agency will report inspection results promptly and in writing to Contractor and the Owner.
 4. Remove and replace work that does not comply with specified requirements.
 5. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.
- E. Repairs And Protection
1. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
 2. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces **OR** top surface, **as directed**, of prime-painted deck immediately after installation, and apply repair paint.
 - a. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.

3. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Final Completion.

END OF SECTION 05 31 13 00

Task	Specification	Specification Description
05 31 33 00	05 31 13 00	Steel Deck
05 36 00 00	05 31 13 00	Steel Deck
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 metallurgically 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 metallurgically 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

Task	Specification	Specification Description
05 54 00 00	05 50 00 00	Metal Fabrications

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SECTION 06 01 20 91 - WOOD RESTORATION

1.1 GENERAL

A. Description Of Work

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

B. Work Included

1. Provide labor, materials and equipment necessary to complete the work of this Section including, but not limited to the following:
 - a. Removal of exterior finish systems at areas of wood restoration or repair
 - b. Preservation and sealing of seams and joints
 - c. Removal of decayed and contaminated wood
 - d. Installation of borate wood preservatives
 - e. Installation of wood repair compound materials
2. Extent of wood restoration work is as required to meet Project requirements.

C. Submittals:

1. Product data, installation instructions, and general recommendations from manufacturer for types of repair required including technical data sheets defining performance properties.
2. Restoration Schedule: Submit schedule for each window, door, cornice, or area of wood trim to be restored, outlining in detail proposed restoration work to be performed on each component. Obtain written approval prior to commencement of repair work.
3. Certification that materials comply with local VOC limitations.
4. Qualification data for firms and persons specified in the "Quality Assurance" article to demonstrate their capabilities and experience. Include a list of completed projects with project name, address, names of Architects and Owners, and information specified.
 - a. Five (5) business days after bid opening, submit a written qualification and experience of all lead personnel for work on the Project. List project manager or foreman's name and experience relative to this Project.
 - b. All work shall be performed by persons whose qualifications have been submitted and approved.

D. Quality Assurance

1. Restorations Specialist: Work must be performed by a firm having not less than (5) years successful experience in comparable wood restoration work including work on at least three (3) buildings listed in the National Register of Historic Places under the direction of federal and state preservation agencies in the last five (5) years and employing personnel skilled in the restoration process and operations indicated.
 - a. Restoration Specialist firm must be acceptable to, or certified by, manufacturer of primary restoration materials.
 - b. Work associated with work of this section, including (but limited to) paint removal and substrate preparation, is to be performed by Installer of the work.
 - c. Only skilled workers who are thoroughly trained and experienced in wood repairs and restoration work at areas as noted, have the skills required for the work of this section, and are completely familiar with the materials and methods specified shall be used for wood restoration work.
 - d. At least one skilled worker shall be present at all times during the execution of the work and shall personally direct the wood repairs and restoration work.
 - e. In acceptance or rejection of the wood restoration work, no allowance will be made for lack of skill on the part of the workers.

2. Manufacturer: Obtain primary repair materials from a single manufacturer. Provide secondary materials as recommended by the manufacturer of the primary materials.

E. Delivery Storage And Handling

1. Deliver all materials in original unopened containers labeled with the manufacturer's name, brand name, item name and installation instructions.
2. Store materials in compliance with the manufacturer's requirements for temperature, maximum and minimum, and other conditions. Keep all materials under cover and dry. Protect against exposure to the weather.
3. Discard and remove from the job site any materials damaged in handling or storage and any materials that have been subjected to conditions contrary to the manufacturer's recommendations or whose maximum shelf life has expired.

F. Project Conditions

1. Lead: Existing paint may contain lead. Take all necessary precautions to ensure the safety of all persons engaged in removing lead-based paint and dispose of all residues generated from lead-based paint stripping in a legal manner in accordance with all local, state and federal codes.
2. Coordination: Coordinate wood repair with paint stripping so that the effected surfaces are exposed for a minimal time to avoid further damage to bare wood. Coordinate with painting so that all restored surfaces are primed as soon as possible after repair.
3. Weather: Proceed with the work of this section only when existing and foreseen weather conditions permit the work to be performed in accordance with the manufacturer's recommendations for temperature and humidity range, minimum and maximum.
4. Substrate Conditions: Do not proceed with product applications until substrates have been inspected and are determined to be in satisfactory conditions. Substrate moisture content shall not be in excess of 18% during preparation and application.
 - a. Remove all decayed wood to a clean, sound, unaffected substrate.
 - b. Remove all built up paints, and other debris to a clean sound substrate.
 - c. Remove all wood sawdust to a clean sound substrate.
5. Protection:
 - a. Use all necessary means to protect interior of building from all damage caused by precipitation and other environmental conditions during the work of the Section.
 - b. Protect all adjacent building surfaces from damage, staining or deterioration resulting from wood restoration work.
 - c. Protect the restoration work in progress to prevent further deterioration exposed wood surfaces. Protect the completed work until the time of final inspection and acceptance by the Owner.
6. Safety: Contractor shall use all means necessary to ensure that no person (whether involved in the work of the Section or not) is harmed or injured due to the work of this Section. Comply with all applicable laws codes and regulations.
7. Security: Coordinate work with the Owner's project manager to ensure that the building is secured at the end of each work period. Review security procedures with the Owner prior to proceeding with the work in this Section.

1.2 PRODUCTS

A. General

1. Compatibility: provide products recommended by the manufacturers to be fully compatible with indicated substrate.

B. Epoxy Repair Products

1. Epoxy repair materials shall consist of 2 separate systems, a 2 part low viscosity epoxy primer/coupling agent and a 2 part thixotropic paste meeting the manufacturer's criteria.
2. Manufacturer of Repair Products and Equipment

- a. Manufacturer: Subject to compliance with the requirements, provide product of the following or approved equal.
 - 1) Advanced Repair Technology
Cherry Valley, NY
 - 2) Window Care Systems
Pembroke, MA
 - 3) or approved equal
- C. Repair Products
 - 1. Low viscosity epoxy coupling/bonding agent
 - 2. Epoxy repair compound
 - 3. Injectable Borate gel
 - 4. Borate rods
- D. Paint Strippers
 - 1. Chemical Stripping Agent. Methylene chloride based, Thixotropic stripper
 - 2. Products: Subject to compliance with requirements, provide the following, or approved equal
 - a. 509 Stripper
 - b. ProSoCo
 - c. or approved equal
 - 3. Low Temperature heat gun or heat plate, no open flame.

1.3 EXECUTION

- A. Inspection
 - 1. Inspect all wood surfaces determine the extent of restoration and methods to be used.
 - a. The decision regarding the extent of required repair, and extent of profile replication work shall be final.
 - b. In wood surfaces where decay is present, determine the methods and treatment of repair.
 - c. Areas that do not attach existing profiles, determine the level of restoration and replication to be achieved.
 - 2. Joints, Joinery and edges: Check wood members at joints, seams and edges for:
 - a. Any open seams or failed conditions.
 - b. Wood moisture content.
 - c. The presence of wood decay, by probing surfaces.
 - 3. Sills and Trim
 - a. Inspect wood surfaces for natural defects (knots) cracks and checks.
 - b. Determine wood moisture content.
 - c. Probe for the presence for wood decay.
- B. Removal
 - 1. Removal of Finishes:
 - a. Remove all peeling and loose paint by scraping, taking care not to damage sound wood and profiles.
 - b. Strip all painted wood surface to bare wood, taking care not to damage sound wood and profiles by the application of stripping paste or by the use of a heat gun or plate
 - 1) Remove stripper and finishes as directed by manufacturer.
 - 2) Dispose of debris in accordance with approved methods.
 - c. Wash all surfaces with recommended neutralizing agents to remove any foreign particle, dust and chemical residue, allow surface to thoroughly dry.
- C. Preventative Systems
 - 1. Preservation and Sealing of seams and joints. Repair of wood "checking" due to weathering.
 - a. Open or failed seams and checks shall be dilated to a width of 3/16" and depth of 1/2".
 - b. Remove all decayed, soft and weathered wood.

- c. Check the moisture content and hardness of wood at and around the repair, maximum allowable moisture content 18%/0.
- d. Sand bare wood to remove all loose fibers, paint, compounds. Remove all sawdust and dirt.
- e. Pre-treat bare and sanded wood thoroughly with low viscosity epoxy coupling/bonding agent
- f. Allow coupling agent to penetrate wood surface for a minimum of 10 minutes and maximum of 30 minutes, or as recommended by the manufacturer. Avoid applying in direct sunlight
- g. Remove any excess bonding agent with absorbing paper
- h. Apply epoxy repair compound over epoxy bonding agent while still tacky.
- i. Epoxy compound shall have optimal contact with wood
- j. Avoid inclusion of air pockets during application
- k. Fill joints fill, even and smooth in one application
- l. Allow full cure time as specified by manufacturer before application of paint or varnish.
- m. After curing, sand surface even and smooth. Transitions and irregularities between wood and epoxy shall not be visible after sanding
- n. If required, smooth any remaining irregularities with an additional application of epoxy repair compound. Always sand between coats.

D. Curative Systems

1. Preservation and Repair of Damaged/Decayed Wood:
 - a. Remove all paint and other coatings from area to be repaired.
 - b. Remove all decayed soft and discolored wood, to sound bright unaffected material
 - c. Check area of removal to determine complete elimination of decayed material.
 - 1) Remaining wood should be even color without red-brown and/or gray spots.
 - 2) No soft wood, existing brittle compound, or other previous repair materials should remain.
 - d. Check moisture content and hardness of the wood in and around the repair area
 - 1) Moisture content of wood to be 18%/0 or less
 - e. Sand bare wood to remove all loose fibers, paint, compounds. Remove all sawdust and dirt.
 - f. Drill holes in effected area to receive borate gel and rods. Follow manufacturer's dose recommendations for dimensional lumber.
 - g. Inject recommended dose of borate gel. Gel should not come in contact with exposed wood surface.
 - h. Install borate rod in same hole as gel. Gel should not come in contact with exposed wood surface.
 - i. Pre-treat bare and sanded wood thoroughly with low viscosity epoxy coupling/bonding agent.
 - 1) Allow coupling/bonding agent to penetrate wood surface for a minimum of 10 minutes and maximum of 30 minutes, or as recommended by the manufacturer. Avoid applying in direct sunlight
 - 2) Remove any excess bonding agent with absorbing paper.
 - j. Apply epoxy repair compound over the uncured epoxy coupling agent.
 - 1) Epoxy fill shall have optimal contact with wood
 - 2) Avoid inclusion of air pockets during application
 - 3) Fill joints fill, even and smooth in one application
 - 4) Allow full cure time as specified by manufacturer before preparing for finishes.
 - k. After curing, sand surface even and smooth. Transitions and irregularities between wood and epoxy shall not be visible after sanding.
 - l. If required, smooth any remaining irregularities with an additional application of epoxy repair compound. Always sand between coats.

E. Adjustments: Repair or replace all defective work at no additional cost to the Owner.

END OF SECTION 06 01 20 91

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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:
- | <u>Sieve Percent</u> | <u>Size Passing (Wt.)</u> |
|----------------------|---------------------------|
| 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 - 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. WWPAA: 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: AWP C2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWP 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 AWWA C20 (lumber) and AWWA 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 WWP.
 - d. Clear Heart **OR** Grade A **OR** Grade B, **as directed**, western red cedar; NLGA, WCLIB, or WWP.
 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 WWP.
 - 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 06 05 23 00a

SECTION 06 05 23 00b - 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 AWPAC15 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 AWPAC31 instead of AWPAC15.
 - b. Treatment with CCA shall include post-treatment fixation process.
2. Pressure treat poles with waterborne preservative to comply with AWPAC4.
 - 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 AWP A 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 AWPAC 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 00b

Task	Specification	Specification Description
06 05 23 00	06 10 00 00	Rough 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 chlorpyrifos 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 AWP A 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

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 AWPB M4.
 - f. Fire-Retardant Treated:
 - 1) Lumber: AWPB C20 Interior Type A.
 - 2) Plywood: AWPB C27 Interior Type A.
 - 3) Bear UL FR-S classification label.
 - g. Pressure-Treated Lumber: Bear AWPB 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: AWPB C27 Interior Type A.
 - 2) Exterior Plywood Fire Retardant Treatment: AWPB 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 new 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 items.
 - 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	06 10 00 00	Rough Carpentry
06 11 16 00	06 05 23 00a	Miscellaneous Carpentry

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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: AWWA 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 AWWA 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-Strand-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	06 05 23 00a	Miscellaneous Carpentry
06 16 33 00	06 10 00 00	Rough Carpentry
06 16 33 00	06 05 23 00a	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	06 05 23 00a	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 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 AWWA C20 (lumber) and AWWA 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 - 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 AWPAC20 (lumber) and AWPAC27 (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, **as 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 06 41 13 00

SECTION 06 46 13 00 - 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: AWWA N1 (dip, spray, flood, or vacuum-pressure treatment).
 - a. Preservative Chemicals: 3-iodo-2-propynyl butyl carbamate (IPBC), combined with an insecticide containing chlorpyrifos (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: AWWA C2 except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWWA C31 with inorganic boron (SBX). Kiln dry after treatment to a maximum moisture content of 19 percent.
 - b. Plywood: AWWA C9. Kiln dry after treatment to a maximum moisture content of 18 percent.
 - c. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
 - d. For exposed items indicated to receive transparent finish, do not use chemical formulations that contain colorants or that bleed through or otherwise adversely affect finishes.
 - e. Do not use material that is warped or does not comply with requirements for untreated material.
 - f. Mark lumber with treatment quality mark of an inspection agency approved by ALSC's Board of Review.

- 1) For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
 - g. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
 - 1) For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.
 - h. Application: Where indicated **OR** All exterior lumber and plywood, **as directed**.
- C. Fire-Retardant-Treated Materials
1. Lumber: Comply with performance requirements in AWPA C20, Exterior type. Kiln dry after treatment to a maximum moisture content of 19 percent.
 2. Plywood: Comply with performance requirements in AWPA C27, Exterior type. Kiln dry after treatment to a maximum moisture content of 15 percent.
 3. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not contain colorants and provide materials that do not have marks from spacer sticks on the exposed face.
 4. Do not use material that does not comply with requirements for untreated material or is warped or discolored.
 5. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
 - a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
 - b. For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.
 6. Application: Where indicated **OR** All exterior lumber and plywood, **as directed**.
- D. Standing And Running Trim
1. Lumber Trim for Semitransparent-Stained Finish **OR** Clear Finish **OR** Unfinished Applications, **as directed**:
 - a. Species and Grade: Redwood, Clear All Heart **OR** Hart B **OR** Clear **OR** Grade B, **as directed**; RIS.
 - b. Species and Grade: Western red cedar, Clear Heart VG (Vertical Grain) **OR** Clear Heart **OR** Grade A **OR** Grade B, **as directed**; NLGA, WCLIB, or WWPA.
 - c. Species and Grade: Hem-fir, pressure-preservative treated; 1 **OR** 2, **as directed**, Common; NLGA, WCLIB, or WWPA.
 - d. Species and Grade: Southern pine, pressure-preservative treated; B & B **OR** C & Btr **OR** D, **as directed**; SPIB.
 - e. Maximum Moisture Content: 19 **OR** 15, **as directed**, percent with at least 85 percent of shipment at 12 percent or less, **as directed**.
 - f. Finger Jointing: Not allowed **OR** Allowed if made with wet-use adhesive complying with ASTM D 5572, **as directed**.
 - g. Face Surface: Surfaced (smooth) **OR** Saw textured, **as directed**.
 2. Lumber Trim for Opaque-Stained **OR** Painted, **as directed**, Finish:
 - a. Species and Grade: Redwood, Clear **OR** Grade B, **as directed**; RIS.
 - b. Species and Grade: Western red cedar, Grade A **OR** B, **as directed**; NLGA, WCLIB, or WWPA.
 - c. Species and Grade: Hem-fir, Prime or D finish **OR** 1 Common **OR** 2 Common, **as directed**; NLGA, WCLIB, or WWPA.
 - d. Species and Grade: Eastern white pine, eastern hemlock-balsam fir-tamarack, eastern spruce, or white woods; D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**; NeLMA, NLGA, WCLIB, or WWPA.
 - e. Species and Grade: Northern white cedar, D Select **OR** 1 Common **OR** 2 Common, **as directed**; NeLMA or NLGA.

- f. Maximum Moisture Content: 19 **OR** 15, **as directed**, percent with at least 85 percent of shipment at 12 percent or less, **as directed**.
- g. Finger Jointing: Not allowed **OR** Allowed if made with wet-use adhesive complying with ASTM D 5572, **as directed**.
- h. Face Surface: Surfaced (smooth) **OR** Saw textured, **as directed**.
- 3. Moldings for Semitransparent-Stained Finish **OR** Clear Finish **OR** Unfinished Applications, **as directed**: WMMPA WM 4, N-grade wood moldings, without finger jointing. Made from kiln-dried stock to patterns included in WMMPA WM 12.
 - a. Species: Redwood **OR** Western red cedar **OR** Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine, **as directed**.
 - b. Brick-Mold Pattern: WM 180, 1-1/4 by 2 inches (32 by 51 mm).
 - c. Drip-Cap Pattern: WM 197, 11/16 by 1-5/8 inches (17 by 41 mm).
 - d. Bed-Mold Pattern: WM 75, 9/16 by 1-5/8 inches (14 by 41 mm).
 - e. Screen-Bead Pattern: WM 144, 1/4 by 3/4 inch (6 by 19 mm).
- 4. Moldings for Opaque-Stained **OR** Painted, **as directed**, Finish: WMMPA WM 4, P-grade wood moldings. Made from kiln-dried stock to patterns included in WMMPA WM 12.
 - a. Species: Redwood **OR** Western red cedar **OR** Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine, **as directed**.
 - b. Finger Jointing: Not allowed **OR** Allowed if made with wet-use adhesive complying with ASTM D 5572, **as directed**.
 - c. Brick-Mold Pattern: WM 180, 1-1/4 by 2 inches (32 by 51 mm).
 - d. Drip-Cap Pattern: WM 197, 11/16 by 1-5/8 inches (17 by 41 mm).
 - e. Bed-Mold Pattern: WM 75, 9/16 by 1-5/8 inches (14 by 41 mm).
 - f. Screen-Bead Pattern: WM 144, 1/4 by 3/4 inch (6 by 19 mm).
- 5. MDO Trim: Exterior Grade B-B, MDO plywood.
- 6. Cellular PVC Trim: Extruded, expanded PVC with a small-cell microstructure, made from UV- and heat-stabilized, rigid material.
 - a. Density: Not less than 31 lb/cu. ft. (500 kg/cu. m).
 - b. Heat Deflection Temperature: Not less than 130 deg F (54 deg C), per ASTM D 648.
 - c. Coefficient of Thermal Expansion: Not more than 4.5×10^{-5} inches/inch x deg F (8.1×10^{-5} mm/mm x deg C).
 - d. Water Absorption: Not more than 1 percent, per ASTM D 570.
 - e. Flame-Spread Index: 75 or less, per ASTM E 84.
- 7. Foam Plastic Moldings: Molded product of shapes indicated, with a tough outer skin on exposed surfaces; factory primed. Exposed surfaces shall not be shaped after molding. Product is recommended by manufacturer for exterior use.
 - a. Density: Not less than 20 lb/cu. ft. (320 kg/cu. m).
 - b. Flame-Spread Index: Not more than 75 when tested according to ASTM E 84.
 - c. Thickness: Not more than 1/2 inch (12.7 mm).
 - d. Width: Not more than 8 inches (204 mm).
 - e. Patterns: As indicated by manufacturer's designations.

E. Lumber Siding

- 1. Provide kiln-dried lumber siding complying with DOC PS 20, factory coated with exterior alkyd primer, **as directed**.
- 2. Species and Grade:
 - a. Clear All Heart VG **OR** Clear All Heart **OR** Clear VG (Vertical Grain) **OR** Clear **OR** Grade B, **as directed**, redwood; RIS.
 - b. Clear VG (Vertical Grain) Heart **OR** Grade A **OR** Grade B, **as directed** western red cedar; NLGA, WCLIB, or WWPA.
 - c. Grade 1 **OR** 2, **as directed**, Common spruce-pine-fir; NeLMA, NLGA, WCLIB, or WWPA.
 - d. Grade Prime or D finish **OR** 1 Common **OR** 2 Common, **as directed**, pressure-preservative-treated hem-fir; NLGA, WCLIB, or WWPA.

- e. Grade D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**, eastern white pine, eastern hemlock-balsam fir-tamarack, eastern spruce, or white woods; NeLMA, NLGA, WCLIB, or WWPA.
 - f. Grade D Select **OR** 1 Common **OR** 2 Common, **as directed**, northern white cedar; NeLMA or NLGA.
 - g. Grade B & B **OR** C & Btr **OR** D **OR** 1 Common **OR** 2 Common, **as directed**, pressure-preservative-treated southern pine; SPIB.
3. Pattern:
- a. Bevel siding, S1S2E, actual overall dimensions of **5-1/2 by 11/16 inch (140 by 17 mm) OR 5-1/2 by 3/4 inch (140 by 19 mm) OR 7-1/4 by 3/4 inch (184 by 19 mm) OR 9-1/4 by 3/4 inch (235 by 19 mm) OR 9-1/4 by 1-3/32 inches (235 by 28 mm)**, **as directed**, measured on the face and thick edge at 19 percent moisture content.
 - b. Drop siding, SPIB or WWPA pattern No. 105, actual face width (coverage) and thickness of **4-7/8 by 9/16 inch (124 by 14 mm) OR 4-7/8 by 23/32 inch (124 by 18 mm) OR 6-5/8 by 23/32 inch (168 by 18 mm) OR 8-5/8 by 23/32 inch (219 by 18 mm)**, **as directed**, measured at 19 percent moisture content.
 - c. V-edge, smooth-faced tongue-and-groove pattern with eased edges, actual face width (coverage) and thickness of **3-1/8 by 9/16 inch (79 by 14 mm) OR 3-1/8 by 23/32 inch (79 by 18 mm) OR 5-1/8 by 23/32 inch (130 by 18 mm) OR 6-7/8 by 23/32 inch (175 by 18 mm)**, **as directed**, measured at 19 percent moisture content.
- F. Plywood Siding
1. Plywood Type: APA-rated siding, pressure-preservative treated, **OR** factory coated with exterior acrylic latex stain, **as directed**, in panel sizes indicated.
 - a. Face Grade: 303-OC **OR** OL **OR** NR **OR** SR, **as directed**.
 - b. Face Grade: 303-6 **OR** 18 **OR** 30, **as directed-S OR W OR S/W, as directed**.
 2. Thickness: **11/32 inch (8.7 mm) OR 3/8 inch (9.5 mm) OR 15/32 inch (11.9 mm) OR 1/2 inch (12.7 mm) OR 19/32 inch (15.1 mm) OR 5/8 inch (15.9 mm) OR As indicated, as directed**.
 3. Face Species: Southern pine **OR** Douglas fir **OR** Western red cedar **OR** Redwood, **as directed**.
 4. Pattern: Plain **OR** Channel groove; grooves **4 inches (101.6 mm) o.c. OR Texture 1-11; grooves 4 inches (101.6 mm) o.c. OR Reverse board-and-batten; grooves 12 inches (304.8 mm) o.c., as directed**.
 5. Surface: Smooth **OR** Rough sawn, **as directed**.
- G. Hardboard Siding
1. Hardboard Siding: AHA A135.6, primed with manufacturer's standard exterior primer.
 - a. Type:
 - 1) **7/16-inch- (11-mm-) thick-by-6-inch- (152-mm-) OR 8-inch- (203-mm-), as directed**, wide lap siding.
 - 2) **1/2-inch- (12.7-mm-) thick-by-8-inch- (203-mm-) wide**, beaded-edge lap siding.
 - 3) **7/16-inch- (11-mm-) thick**, shiplap-edge panels; with grooves **3-5/8 inches (92 mm) o.c.**, simulating wood drop siding.
 - 4) **1/2-inch- (12.7-mm-) thick**, shiplap-edge panels; with grooves **5-1/2 inches (140 mm) o.c.**, simulating wood drop siding.
 - 5) **7/16-inch- (11-mm-) thick**, square-edge flat panels; without grooves.
 - 6) **7/16-inch- (11-mm-) thick**, shiplap-edge panels; channel grooved with grooves **8 inches (203.2 mm) o.c.**
 - b. Texture: Smooth **OR** Wood grain **OR** Shingle **OR** Stucco, **as directed**.
 2. Primed Hardboard Trim: High-temperature-cured, high-resin, wood-fiber composite; factory primed on faces and edges. Recommended by manufacturer for exterior use.
 3. Colors, Textures, and Patterns: As selected by the Owner from manufacturer's full range.
- H. Plywood Soffits
1. Plywood Type: Exterior, Grade A-C **OR** Grade B-C **OR** Grade C-C, plugged and touch sanded **OR** APA-rated siding, **as directed**.
 - a. Face Grade: 303-OC **OR** OL **OR** NR **OR** SR, **as directed**.

- b. Face Grade: 303-6 **OR** 18 **OR** 30, **as directed**, -S **OR** W **OR** S/W, **as directed**.
 2. Thickness: **11/32 inch (8.7 mm)** **OR** **3/8 inch (9.5 mm)** **OR** **15/32 inch (11.9 mm)** **OR** **1/2 inch (12.7 mm)** **OR** **19/32 inch (15.1 mm)** **OR** As indicated, **as directed**.
 3. Face Species: Southern pine **OR** Douglas fir **OR** Western red cedar **OR** Redwood, **as directed**.
 4. Pattern: Plain **OR** Channel groove; grooves **4 inches (101.6 mm)** o.c. **OR** Texture 1-11; grooves **4 inches (101.6 mm)** o.c., **as directed**.
 5. Surface: Smooth **OR** Rough sawn, **as directed**.
- I. Hardboard Soffits
 1. Hardboard Soffits: Primed hardboard, complying with AHA A135.6, with manufacturer's standard exterior primer.
 - a. Type: **7/16-inch- (11-mm-)** **OR** **1/2-inch- (12.7-mm-)**, **as directed**, thick flat panels, smooth **OR** wood-grain textured **OR** stucco textured, **as directed**.
 2. Colors, Textures, and Patterns: As selected by the Owner from manufacturer's full range.
- J. Stairs And Railings
 1. Stairs:
 - a. Treads: **1-1/4-inch (32-mm)** thick, kiln-dried, pressure-preservative-treated stepping with half-round or rounded edge nosing.
 - 1) Species and Grade: Douglas fir, C & Btr VG (Vertical Grain) stepping; NLGA, WCLIB, or WWPA **OR** Hem-fir, C & Btr VG (Vertical Grain) stepping; NLGA, WCLIB, or WWPA **OR** Southern pine, B & B stepping; SPIB, **as directed**.
 - b. Risers: **3/4-inch (19-mm)** thick, kiln-dried, pressure-preservative-treated finish boards.
 - 1) Species and Grade: Douglas fir, C & Btr or Superior finish; NLGA, WCLIB, or WWPA **OR** Hem-fir, C & Btr or Superior finish; NLGA, WCLIB, or WWPA **OR** Southern pine, B & B; SPIB, **as directed**
 2. Railings: Clear, kiln-dried, solid, yellow poplar **OR** pressure-preservative-treated Douglas fir **OR** pressure-preservative-treated southern pine, **as directed**; railing stock of pattern indicated.
 3. Balusters: **1-1/16-inch- (27-mm-)** square, clear, kiln-dried, solid, yellow poplar **OR** pressure-preservative-treated Douglas fir **OR** pressure-preservative-treated southern pine, **as directed**.
 4. Newel Posts: Clear, kiln-dried, yellow poplar **OR** pressure-preservative-treated, Douglas fir **OR** pressure-preservative-treated, southern pine, **as directed**, turned newel posts of pattern and size indicated.
 5. Newel Posts: **2-3/4-inch- (70-mm-)** square, clear, kiln-dried yellow poplar **OR** pressure-preservative-treated Douglas fir **OR** pressure-preservative-treated southern pine, **as directed**; either solid or laminated.
- K. Ornamental Wood Columns
 1. Factory fabricate columns from clear stock, either solid or finger jointed, with a moisture content of not more than 15 **OR** 19, **as directed**, percent.
 - a. Wood Species: Redwood **OR** Western red cedar **OR** Eastern white, Idaho white, lodgepole, ponderosa, or sugar pine, **as directed**.
 2. Shafts: Built up from tongue-and-groove staves joined with waterproof glue. Lathe turn shafts to provide base diameter indicated and true architectural entasis taper. Precisely mill flutes as indicated.
 3. Capital and Base: Molded glass-fiber-reinforced plastic **OR** Built up from wood components with waterproof glue. Turn circular elements on lathes.
 4. Plinths: Cast-aluminum or molded glass-fiber-reinforced plastic, constructed to ventilate the interior of column shaft.
 5. Treatment and Finishing:
 - a. Treat wood columns with water-repellant preservative by nonpressure process.
 - b. Coat inside of column shafts with bituminous mastic.
 - c. Prime columns with two coats of exterior alkyd wood primer compatible with specified topcoats.

L. Miscellaneous Materials

1. Fasteners for Exterior Finish Carpentry: Provide nails or screws, in sufficient length to penetrate not less than **1-1/2 inches (38 mm)** into wood substrate.
 - a. For face-fastening siding, provide ringed-shank siding nails unless hot-dip galvanized nails are used.
 - b. For redwood, provide brass/bronze **OR** stainless-steel **OR** hot-dip galvanized steel, **as directed**, fasteners.
 - c. For prefinished items, provide matching prefinished aluminum fasteners where face fastening is required.
 - d. For pressure-preservative-treated wood, provide stainless-steel **OR** hot-dip galvanized steel, **as directed**, fasteners.
 - e. For applications not otherwise indicated, provide stainless-steel **OR** hot-dip galvanized steel **OR** aluminum, **as directed**, fasteners.
2. Wood Glue: Waterproof resorcinol glue recommended by manufacturer for exterior carpentry use.
3. Adhesive for Cellular PVC Trim: Product recommended by trim manufacturer.
4. Flashing: Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing materials installed in exterior finish carpentry.
 - a. Horizontal Joint Flashing for Panel Siding: Preformed, galvanized steel **OR** aluminum **OR** prefinished aluminum **OR** stainless-steel, **as directed**, Z-shaped flashing.
5. Insect Screening for Soffit Vents: Aluminum, **18-by-16 (1.4-by-1.6-mm)** mesh **OR** PVC-coated glass-fiber fabric, **18-by-14 (1.4-by-1.8-mm)** or **18-by-16 (1.4-by-1.6-mm)** mesh **OR** Stainless steel, **18-by-18 (1.4-by-1.4-mm)** mesh, **as directed**.
6. Continuous Soffit Vents: Aluminum hat channel shape with stamped louvers **OR** perforations, **as directed**, **2 inches (51 mm)** wide, and in lengths not less than **96 inches (2438 mm)**.
 - a. Net Free Area: **4 sq. in./linear ft. (280 sq. cm/m)** **OR** **6 sq. in./linear ft. (420 sq. cm/m)** **OR** **8 sq. in./linear ft. (560 sq. cm/m)**, **as directed**.
 - b. Finish: Mill finish **OR** White paint **OR** Brown paint, **as directed**.
7. Round Soffit Vents: Stamped aluminum louvered vents, **2 inches (51 mm)** **OR** **2-1/2 inches (64 mm)** **OR** **3 inches (76 mm)** **OR** **4 inches (102 mm)**, **as directed**, in diameter, made to be inserted into round holes cut into soffit.
 - a. Finish: Mill finish **OR** White paint **OR** Brown paint, **as directed**.
8. Sealants: Latex, complying with ASTM C 834, Type P, Grade NF and with applicable requirements in Division 07 Section "Joint Sealants", recommended by sealant manufacturer and manufacturer of substrates for intended application.

M. Fabrication

1. Back out or kerf backs of standing and running trim wider than **5 inches (125 mm)**, except members with ends exposed in finished work.
2. Ease edges of lumber less than **1 inch (25 mm)** in nominal thickness to **1/16-inch (1.5-mm)** radius and edges of lumber **1 inch (25 mm)** or more in nominal thickness to **1/8-inch (3-mm)** radius.

1.3 EXECUTION

A. Preparation

1. Clean substrates of projections and substances detrimental to application.
2. Prime lumber to be painted, including both faces and edges. Cut to required lengths and prime ends. Comply with requirements in Division 09 Section "Exterior Painting".

B. Installation, General

1. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.
 - a. Do not use manufactured units with defective surfaces, sizes, or patterns.
2. Install exterior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.

- a. Scribe and cut exterior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
 - b. Install to tolerance of **1/8 inch in 96 inches (3 mm in 2438 mm)** for level and plumb. Install adjoining exterior finish carpentry with **1/32-inch (0.8-mm)** maximum offset for flush installation and **1/16-inch (1.5-mm)** maximum offset for reveal installation.
 - c. Install stairs with no more than **3/16-inch (4.7-mm)** variation between adjacent treads and risers and with no more than **3/8-inch (9.5-mm)** variation between largest and smallest treads and risers within each flight.
 - d. Coordinate exterior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate exterior finish carpentry.
- C. Standing And Running Trim Installation
1. Install flat grain lumber with bark side exposed to weather.
 2. Install cellular PVC trim to comply with manufacturer's written instructions.
 3. Install trim with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than **24 inches (610 mm)** long except where necessary.
 - a. Use scarf joints for end-to-end joints.
 - b. Stagger end joints in adjacent and related members.
 4. Fit exterior joints to exclude water. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Plane backs of casings to provide uniform thickness across joints, where necessary for alignment.
 5. Unless otherwise indicated, countersink fasteners, fill surface flush, and sand where face fastening is unavoidable.
- D. Siding Installation
1. Install siding to comply with manufacturer's written instructions and warranty requirements.
 2. Horizontal Lumber Siding: Apply starter strip along bottom edge of sheathing or sill. Install first course of siding with lower edge at least **1/8 inch (3 mm)** below starter strip and subsequent courses lapped **1 inch (25 mm)** over course below. Nail at each stud. Do not allow nails to penetrate more than one thickness of siding.
 3. Diagonal Lumber Siding: Begin application at corner with tongue edge up. Install subsequent courses with tongue-and-groove edges tightly fitted together. Nail at each stud.
 - a. Leave **1/8-inch (3-mm)** gap at trim and corners unless otherwise recommended by manufacturer, and apply sealant.
 - b. Butt joints only over framing or blocking, nailing top and bottom on each side and staggering joints in subsequent courses.
 - c. Install prefabricated outside corners as recommended by manufacturer of siding materials.
 4. Plywood Siding: Install panels with edges over framing or blocking. Nail at **6 inches (150 mm)** o.c. at panel perimeter and **12 inches (300 mm)** o.c. at intermediate supports unless manufacturer recommends closer spacing. Leave **1/16-inch (1.5-mm)** gap between adjacent panels and **1/8-inch (3-mm)** gap at perimeter, openings, and horizontal joints unless otherwise recommended by panel manufacturer.
 - a. Seal butt joints at inside and outside corners and at trim locations.
 - b. Install continuous metal flashing at horizontal panel joints.
 - c. Apply battens and corner trim as indicated. Countersink nail heads, fill flush, and sand filler.
 - d. Conceal fasteners to greatest practical extent by countersinking and filling, by placing in grooves of siding pattern or by concealing with applied trim or battens as detailed. Do not nail through overlapping pieces.
 5. Hardboard Siding: Install hardboard siding complying with AHA's "Recommended Basic Application and Painting Instructions for Hardboard Siding." Install panels with edges over framing or blocking. Leave **3/16-inch (5-mm)** gap at perimeter, openings, and horizontal panel joints unless otherwise recommended by panel manufacturer.
 - a. Seal butt joints at inside and outside corners and at trim locations.

- b. Install continuous metal flashing at horizontal panel joints.
 - c. Apply battens and corner trim as indicated.
 - d. Conceal fasteners to greatest practical extent by placing in grooves of siding pattern or by concealing with applied trim or battens as detailed.
 6. Flashing: Install metal flashing as indicated on Drawings and as recommended by siding manufacturer.
 7. Finish: Apply finish within two weeks of installation.
- E. Stair And Railing Installation
 1. Treads and Risers at Exterior Stairs: Secure treads and risers by gluing and nailing to carriages. Countersink nail heads, fill flush, and sand filler. Extend treads over carriages and finish with bullnose edge.
 2. Balusters: Fit balusters to treads, glue, and nail in place. Countersink nail heads, fill flush, and sand filler. Let into railings and glue in place.
 3. Newel Posts: Secure newel posts to stringers and risers with through bolts **OR** lag screws **OR** countersunk-head wood screws and glue, **as directed**.
 4. Railings: Secure wall rails with metal brackets. Fasten freestanding railings to newel posts and to trim at walls with countersunk-head wood screws or rail bolts, and glue.
- F. Ornamental Column Installation
 1. Install columns to comply with manufacturer's written instructions. Comply with requirements below unless manufacturer's written instructions state otherwise.
 2. Lay out column locations on soffits and beams and plumb down to locate column locations at supports.
 3. Set plinths in location, shim as required to temporarily level, and scribe and trim as required so that top of plinths will sit level without use of shims. Fasten plinths in place to support using pins or fasteners as recommended by manufacturer.
 4. Scribe and trim tops of columns to fit to soffits and beams. Maintain ventilation passages to interior of columns.
 5. Seal ends of columns with two coats of wood sealer or primer.
 6. Install column caps and flashing on columns and fasten to column. Install caps and flashing so that loads are not imposed on caps and so that ventilation of column interior is not blocked.
 7. Secure columns in place at top and bottom with fasteners recommended by manufacturer.
- G. Adjusting
 1. Replace exterior finish carpentry that is damaged or does not comply with requirements. Exterior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.
- H. Cleaning
 1. Clean exterior finish carpentry on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.
- I. Protection
 1. Protect installed products from damage from weather and other causes during construction.
 2. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
 - a. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - b. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 06 46 13 00

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SECTION 06 46 13 00a - 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: AWWA C2 **OR** AWWA C31 (treated with inorganic boron), **as directed**. Kiln dry after treatment to a maximum moisture content of 19 percent.
2. Plywood: AWWA 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 AWWA 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 AWWA 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 WWP.
 - 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 WWP.
 - 4) White woods, C Select **OR** D Select **OR** 1 Common **OR** 2 Common, **as directed**; WWP.
 - 5) Douglas fir-larch or Douglas fir south, Superior or C & Btr **OR** Prime or D, **as directed**, finish; NLGA, WCLIB, or WWP.
 - 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 WWP.
 - 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 WWP.
 - 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 WWP.
 - 4) White woods, D Select **OR** 1 Common **OR** 2 Common, **as directed**; WWP.
 - 5) Douglas fir-larch or Douglas fir south, Superior or C & Btr **OR** Prime or D, **as directed**, finish; NLGA, WCLIB, or WWP.
 - 6) Spruce-pine-fir, 1 **OR** 2, **as directed**, Common; NeLMA, NLGA, WCLIB, or WWP.
 - 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 06 46 13 00a

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Task	Specification	Specification Description
06 46 13 00	06 05 23 00a	Miscellaneous Carpentry
06 46 19 00	01 22 16 00	No Specification Required
06 46 19 00	06 05 23 00a	Miscellaneous Carpentry
06 46 19 00	06 46 13 00	Exterior Finish Carpentry
06 46 19 00	06 46 13 00a	Interior Finish Carpentry
06 46 19 00	06 41 13 00	Interior Architectural Woodwork
06 46 23 00	06 41 13 00	Interior Architectural Woodwork
06 46 26 00	06 41 13 00	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 jams.
 - 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 AWPAN1 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 AWPAN8 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 AWPAN8.
2. Preservative Treatment by Pressure Process: AWPAN2 (lumber) and AWPAN9 (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 AWPAN20 (lumber) and AWPAN27 (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	06 41 13 00	Interior Architectural Woodwork
06 65 00 00	06 05 23 00a	Miscellaneous Carpentry

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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 AWC 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 slabs 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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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 92 13 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** 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 92 13 00

SECTION 08 01 52 61 - WOOD WINDOWS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of material for wood windows. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes fixed and operable wood-framed windows of the following type:
 - a. Unfinished.
 - b. Aluminum clad.
 - c. Vinyl clad.

C. Definitions

1. Performance class designations according to AAMA/WDMA 101/I.S.2/NAFS:
 - a. AW: Architectural.
 - b. HC: Heavy Commercial.
 - c. C: Commercial.
 - d. LC: Light Commercial.
 - e. R: Residential.
2. Performance grade number according to AAMA/WDMA 101/I.S.2/NAFS:
 - a. Design pressure number in **pounds force per square foot (pascals)** used to determine the structural test pressure and water test pressure.
3. Structural Test Pressure: For uniform load structural test, is equivalent to 150 percent of the design pressure.
4. Minimum Test Size: Smallest size permitted for performance class (gateway test size). Products must be tested at minimum test size or at a size larger than minimum test size to comply with requirements for performance class.

D. Performance Requirements

1. General: Provide wood windows capable of complying with performance requirements indicated, based on testing manufacturer's windows that are representative of those specified, and that are of test size required by AAMA/WDMA 101/I.S.2/NAFS.
2. Structural Performance: Provide wood windows capable of withstanding the effects of the following loads based on testing units representative of those indicated for Project that pass AAMA/WDMA 101/I.S.2/NAFS, Uniform Load Structural Test:
 - a. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in **miles per hour (meters per second)** at **33 feet (10 m)** above grade, according to ASCE 7, Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade indicated on Drawings.
 - 1) Basic Wind Speed: **85 mph (38 m/s) OR 90 mph (40 m/s), as directed.**
 - 2) Importance Factor: **I OR II OR III OR IV, as directed.**
 - 3) Exposure Category: **A OR B OR C OR D, as directed.**
 - b. Deflection: Design glass framing system to limit lateral deflections of glass edges to less than 1/175 of glass-edge length or **3/4 inch (19 mm)**, whichever is less, at design pressure based on testing performed according to AAMA/WDMA 101/I.S.2/NAFS, Uniform Load Deflection Test or structural computations.
3. Windborne-Debris Resistance: Provide glazed windows capable of resisting impact from windborne debris, based on the pass/fail criteria as determined from testing glazed windows identical to those specified, according to ASTM E 1886 and testing information in ASTM E 1996 **OR AAMA 506, as directed**, and requirements of authorities having jurisdiction.

E. Submittals

1. Product Data: For each type of wood window indicated.
2. LEED Submittal:
 - a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood windows comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
 - 1) Include statement indicating costs for each certified wood product.
3. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other work, operational clearances, installation details.
4. Samples: For each exposed finish.
5. Product Schedule: Use same designations indicated on Drawings.
6. Product test reports.
7. Maintenance data.

F. Quality Assurance

1. Installer: A qualified installer, approved by manufacturer to install manufacturer's products.
2. Manufacturer Qualifications: A qualified manufacturer who is certified for chain of custody by an FSC-accredited certification body.
3. Forest Certification: Provide windows made with not less than 70 percent of wood products **OR** all wood products, **as directed**, obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
4. Fenestration Standard: Comply with AAMA/WDMA 101/I.S.2/NAFS, "North American Fenestration Standard Voluntary Performance Specification for Windows, Skylights and Glass Doors," for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
 - a. Provide AAMA-certified **OR** WDMA-certified, **as directed**, wood windows with an attached label.
5. Glazing Publications: Comply with published recommendations of glass manufacturers and with GANA's "Glazing Manual" unless more stringent requirements are indicated.
6. Preinstallation Conference: Conduct conference at Project site.

G. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace wood windows that fail in materials or workmanship within specified warranty period.
 - a. Warranty Period:
 - 1) Window: Two **OR** Three, **as directed**, years from date of Final Completion.
 - 2) Glazing: Five **OR** 10, **as directed**, years from date of Final Completion.
 - 3) Metal Finish: Five years from date of Final Completion.

1.2 PRODUCTS**A. Materials**

1. Wood: Clear ponderosa pine or another suitable fine-grained lumber; kiln dried to a moisture content of 6 to 12 percent at time of fabrication; free of visible finger joints, blue stain, knots, pitch pockets, and surface checks larger than 1/32 inch (0.8 mm) deep by 2 inches (51 mm) wide; water-repellent preservative treated.
2. Aluminum Extrusions and Rolled Aluminum for Cladding: Manufacturer's standard formed sheet or extruded-aluminum cladding, mechanically bonded to exterior exposed wood members. Provide aluminum alloy and temper recommended by wood window manufacturer for strength, corrosion resistance, and application of required finish, but not less than 22,000-psi (150-MPa) ultimate tensile strength, and not less than 16,000-psi (110-MPa) minimum yield strength.
 - a. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- b. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- c. Baked-Enamel Finish for Extrusions and Sheet: Manufacturer's standard baked enamel complying with AAMA 2603 and paint manufacturer's written specifications for cleaning, conversion coating, and painting.
 - 1) Color: White **OR** Bronze **OR** Brown **OR** Beige **OR** Gray **OR** Green **OR** As selected from manufacturer's full range **OR** Custom color as selected, **as directed**.
- d. High-Performance Organic Finish for Extrusions and Sheet: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1) Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2604.
 - a) Color and Gloss: As selected from manufacturer's full range.
- e. Baked-Enamel Finish for Coil: Manufacturer's standard baked enamel complying with AAMA 620 and paint manufacturer's written specifications for cleaning, conversion coating, and painting.
 - 1) Color: White **OR** Bronze **OR** Brown **OR** Beige **OR** Gray **OR** Green **OR** As selected from manufacturer's full range **OR** Custom color as selected, **as directed**.
3. Vinyl for Cladding: Consisting of a rigid PVC sheath, made from PVC complying with ASTM D 4726, not less than **35-mil (0.9-mm)** average thickness, in permanent, integral color, white **OR** bronze **OR** tan, **as directed**, finish, mechanically bonded to exterior wood sash and frame members.
4. Wood Trim and Glazing Stops: Material and finish to match frame members.
5. Clad Trim and Glazing Stops: Hollow extrusions **OR** Roll-formed sheet material **OR** Clad-wood material, **as directed**, and finish to match clad frame members.
6. Fasteners: Aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be noncorrosive and compatible with wood window members, cladding, trim, hardware, anchors, and other components.
 - a. Exposed Fasteners: Unless unavoidable for applying hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate.
7. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.
8. Reinforcing Members: Aluminum, or nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.
9. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action and for complete concealment when wood window is closed.
 - a. Weather-Stripping Material:
 - 1) Elastomeric cellular preformed gaskets complying with ASTM C 509.
 - 2) Dense elastomeric gaskets complying with ASTM C 864.
 - 3) Manufacturer's standard system and materials complying with AAMA/WDMA 101/I.S.2/NAFS.
10. Sliding-Type Weather Stripping: Provide woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric. Comply with AAMA 701/702.
 - a. Weather Seals: Provide weather stripping with integral barrier fin or fins of semirigid, polypropylene sheet or polypropylene-coated material. Comply with AAMA 701/702.
11. Replaceable Weather Seals: Comply with AAMA 701/702.

B. Window

1. Window Type: Casement **OR** Double hung **OR** Fixed **OR** Horizontal sliding **OR** Projected awning **OR** Single hung **OR** Bay **OR** Bow **OR** Specialty product **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
2. AAMA/WDMA Performance Requirements: Provide wood windows of performance indicated that comply with AAMA/WDMA 101/I.S.2/NAFS unless more stringent performance requirements are indicated.
 - a. Performance Class and Grade: R15 **OR** 20 **OR** 25, **as directed**.
 - b. Performance Class and Grade: LC25 **OR** 30 **OR** 35, **as directed**.
 - c. Performance Class and Grade: C30 **OR** 35 **OR** 40, **as directed**.
 - d. Performance Class and Grade: HC40 **OR** 45 **OR** 50, **as directed**.
 - e. Performance Class and Grade: AW40 **OR** 45 **OR** 50, **as directed**.
 - f. Performance Class and Grade: As indicated.
3. Condensation-Resistance Factor (CRF): Provide wood windows tested for thermal performance according to AAMA 1503, showing a CRF of 45 **OR** 52, **as directed**.
4. Thermal Transmittance: Provide wood windows with a whole-window, U-factor maximum indicated at 15-mph (24-km/h) exterior wind velocity and winter condition temperatures when tested according to AAMA 1503 **OR** ASTM E 1423 **OR** NFRC 100, **as directed**.
 - a. U-Factor: 0.35 Btu/sq. ft. x h x deg F (2.0 W/sq. m x K) **OR** 0.40 Btu/sq. ft. x h x deg F (2.3 W/sq. m x K) **OR** 0.43 Btu/sq. ft. x h x deg F (2.5 W/sq. m x K) **OR** 0.60 Btu/sq. ft. x h x deg F (3.4 W/sq. m x K), **as directed**, or less.
5. Solar Heat-Gain Coefficient (SHGC): Provide wood windows with a whole-window SHGC maximum of 0.40 **OR** 0.50 **OR** 0.55, **as directed**, determined according to NFRC 200 procedures.
6. Sound Transmission Class (STC): Provide glazed windows rated for not less than 26 **OR** 30 **OR** 35, **as directed**, STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.
7. Air Infiltration: Maximum rate not more than indicated when tested according to AAMA/WDMA 101/I.S.2/NAFS, Air Infiltration Test.
 - a. Maximum Rate:
 - 1) 0.3 cfm/sq. ft. (5 cu. m/h x sq. m) of area at an inward test pressure of 1.57 lbf/sq. ft. (75 Pa) which is equivalent to 25-mph (40-km/h) wind speed and is typically used to test R, C, and LC performance classes.
 - 2) 0.3 cfm/sq. ft. (5 cu. m/h x sq. m) of area at an inward test pressure of 6.24 lbf/sq. ft. (300 Pa) which is equivalent to a 50-mph (80-km/h) wind speed and is typically used to test HC and AW performance classes.
 - b. Water Resistance: No water leakage as defined in AAMA/WDMA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/WDMA 101/I.S.2/NAFS, Water Resistance Test.
 - c. Test Pressure:
 - 1) 15 percent of positive design pressure, but not less than 2.86 lbf/sq. ft. (140 Pa) or more than 15 lbf/sq. ft. (720 Pa).
 - 2) 20 percent of positive design pressure, but not more than 15 lbf/sq. ft. (720 Pa).
8. Forced-Entry Resistance: Comply with Performance Grade 10 **OR** 20 **OR** 30 **OR** 40, **as directed**, requirements when tested according to ASTM F 588.
9. Life-Cycle Testing: Test according to AAMA 910 and comply with AAMA/WDMA 101/I.S.2/NAFS.
10. Operating Force and Auxiliary (Durability) Tests: Comply with AAMA/WDMA 101/I.S.2/NAFS for operating window types indicated.

C. Glazing

1. Glass and Glazing Materials: Refer to Division 08 Section "Glazing" for glass units and glazing requirements applicable to glazed wood window units.
2. Glass: Clear, insulating-glass units **OR** Clear, insulating-glass units, with low-E coating pyrolytic on second surface or sputtered on second or third surface, **OR** Clear, insulating-glass units,

- argon gas filled, with low-E coating pyrolytic on second surface or sputtered on second or third surface, **as directed**, complying with Division 08 Section "Glazing".
3. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal **OR** Manufacturer's standard factory-glazing system that produces weathertight seal and complies with requirements for windborne-debris resistance **OR** Manufacturer's standard factory-glazing system as indicated in Division 08 Section "Glazing", **as directed**.
 4. Dual-Glazing System for Venetian Blinds: Manufacturer's standard dual-glazing system with 2 lites of clear float glass, complying with ASTM C 1036, Type I, Quality q3, glazed independently into the sash and separated by a minimum dead-air space of **1-1/2 inches (38 mm)**.
 5. Triple-Glazing System for Venetian Blinds: Manufacturer's standard insulated glass of type specified, combined with an auxiliary lite of clear float glass, complying with ASTM C 1036, Type I, Quality q3, retained in a separate glazing channel or frame and separated from insulated-glass unit by a minimum dead-air space of **1-1/2 inches (38 mm)**.
- D. Hardware
1. General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with wood and aluminum cladding, **as directed**; designed to smoothly operate, tightly close, and securely lock wood windows, and sized to accommodate sash or ventilator weight and dimensions. Do not use aluminum in frictional contact with other metals. Where exposed, provide solid bronze **OR** extruded, cast, or wrought aluminum **OR** die-cast zinc with special coating finish **OR** nonmagnetic stainless steel, **as directed**.
 2. Counterbalancing Mechanism: Comply with AAMA 902.
 - a. Sash-Balance Type: Concealed, tape-spring **OR** spiral-tube **OR** spring-loaded, block-and-tackle, **as directed**, type, of size and capacity to hold sash stationary at any open position.
 3. Sill Cap/Track: Extruded-aluminum track with natural anodized finish **OR** Rigid PVC or other weather-resistant plastic track with manufacturer's standard integral color, **as directed**, of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.
 4. Locks and Latches: Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only. Provide custodial locks, **as directed**.
 5. Roller Assemblies: Low-friction design.
 6. Push-Bar Operators: Provide telescoping-type, push-bar operator designed to open and close ventilators with fixed screens.
 7. Gear-Type Rotary Operators: Comply with AAMA 901 when tested according to ASTM E 405, Method A.
 - a. Operation Function: All ventilators move simultaneously and securely close at both jambs without using additional manually controlled locking devices.
 8. Four- or Six-Bar Friction Hinges: Comply with AAMA 904.
 - a. Locking mechanism and handles for manual operation.
 - b. Friction Shoes: Provide friction shoes of nylon or other nonabrasive, nonstaining, noncorrosive, durable material.
 9. Limit Devices: Provide concealed friction adjustor, adjustable stay bar **OR** concealed support arms with adjustable, limited, hold-open, **as directed**, limit devices designed to restrict sash or ventilator opening.
 - a. Safety Devices: Limit clear opening to **4 inches (100 mm) OR 6 inches (150 mm)**, **as directed**, for ventilation; with custodial key release.
 10. Pole Operators: Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than **60 inches (1500 mm)** above floor; 1 pole operator and pole hanger per room that has operable windows more than **72 inches (1800 mm)** above floor.
- E. Insect Screens
1. General: Design windows and hardware to accommodate screens in a tight-fitting, removable arrangement, with a minimum of exposed fasteners and latches. Fabricate insect screens to fully

integrate with window frame. Locate screens on inside **OR** outside, **as directed**, of window and provide for each operable exterior sash or ventilator.

- a. Aluminum Tubular Frame Screens: Comply with SMA 1004, "Specifications for Aluminum Tubular Frame Screens for Windows," Residential R-20 **OR** Architectural C-24 **OR** Monumental M-32, **as directed**, class.
2. Aluminum Insect Screen Frames: Manufacturer's standard aluminum alloy complying with SMA 1004. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, adjustable rollers, **as directed**, and removable PVC spline/anchor concealing edge of frame.
 - a. Aluminum Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet with minimum wall thickness as required for class indicated.
 - b. Finish:
 - 1) Anodized aluminum **OR** Baked-on organic coating, **as directed**, in manufacturer's standard color **OR** in color selected from manufacturer's full range, **as directed**.
OR
Manufacturer's standard.
3. Glass-Fiber Mesh Fabric: **18-by-14 (1.1-by-1.4-mm)** or **18-by-16 (1.0-by-1.1-mm)** **OR** **20-by-20 (0.85-by-0.85-mm)** or **20-by-30 (0.85-by-0.42-mm)**, **as directed**, mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration; in the following color. Comply with ASTM D 3656.
 - a. Mesh Color: Charcoal gray **OR** Silver gray **OR** Aquamarine, **as directed**.
4. Aluminum Wire Fabric: **18-by-16 (1.1-by-1.3-mm)** mesh of **0.011-inch- (0.28-mm-)** diameter, coated aluminum wire.
 - a. Wire-Fabric Finish: Natural bright **OR** Charcoal gray **OR** Black, **as directed**.
5. Wickets: Provide sliding **OR** hinged, **as directed**, wickets, framed and trimmed for a tight fit and for durability during handling.

F. Accessories

1. Dividers (False Muntins): Provide dividers in designs indicated for each sash lite, one per sash, removable from the exposed surface of interior lite of the sash **OR** two per sash, removable from the exposed surfaces of interior and exterior lites of the sash, **as directed**, and one permanently located between glazing lites in the airspace, **as directed**.
 - a. Material: Extruded, rigid PVC **OR** Prefinished wood, **as directed**.
 - b. Design: Rectangular **OR** Diamond, **as directed**.
 - c. Color: White **OR** Bronze, **as directed**.
2. Storm Panels: Provide removable auxiliary glazing panels of clear float glass for each fixed and operating sash of window units. Glass shall comply with ASTM C 1036, Type I, Quality q3. Provide glass of thickness required to comply with requirements in Division 08 Section "Glazing". Frame, preglaze, and attach storm windows to the sash according to manufacturer's published standards. Omit storm panels on sash glazed with insulating glass, **as directed**.
3. Integral Louver Blinds: Provide remotely operated horizontal louver blinds in the space between two panes of glass. Construct blinds of aluminum slats, approximately **1 inch (25 mm)** wide, with polyester fiber cords, equipped for tilting, raising, and lowering by standard operating hardware located on inside face of sash.

G. Fabrication

1. Fabricate wood windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
2. Fabricate wood windows that are reglazable without dismantling sash or ventilator framing.
3. Weather Stripping: Provide full-perimeter weather stripping for each operable sash and ventilator, unless otherwise indicated.
 - a. Double-Hung Windows: Provide weather stripping only at horizontal rails of operable sash.
4. Factory machine windows for openings and for hardware that is not surface applied.
5. Mullions: Provide mullions and cover plates as shown, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances

and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of window units.

6. Factory-Glazed Fabrication: Except for light sizes in excess of **100 united inches (2500 mm width plus length)**, glaze wood windows in the factory where practical and possible for applications indicated. Comply with requirements in Division 08 Section "Glazing" and with AAMA/WDMA 101/I.S.2/NAFS.
7. Glazing Stops: Provide nailed or snap-on glazing stops coordinated with Division 08 Section "Glazing" and glazing system indicated. Provide glazing stops to match sash and ventilator frames.
8. Bow **OR** Bay, **as directed**, Windows: Provide wood windows in configuration indicated. Provide window frames, fixed and operating sash, operating hardware, and other trim and components necessary for a complete, secure, and weathertight installation, including the following:
 - a. Angled mullion posts with interior and exterior trim.
 - b. Angled interior and exterior extension and trim.
 - c. Clear pine head and seat boards.
 - d. Top and bottom plywood platforms.
 - e. Exterior head and sill casings and trim.
 - f. Support brackets.
9. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation. Allow for scribing, trimming, and fitting at Project site.

H. Wood Finishes

1. Factory-Primed Windows: Provide manufacturer's standard factory-prime coat complying with WDMA T.M. 11 on exposed exterior **OR** interior **OR** exterior and interior, **as directed**, wood surfaces.
2. Factory-Finished Windows: Provide manufacturer's standard factory finish complying with WDMA T.M. 12. Apply finish to exposed exterior and interior wood surfaces.
 - a. Color: White **OR** Brown **OR** Gray **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation

1. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing windows, hardware, accessories, and other components.
2. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.
3. Set sill members in bed of sealant or with gaskets, as indicated, for weathertight construction.
4. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

B. Adjusting, Cleaning, And Protection

1. Adjust operating sashes and ventilators, screens, hardware, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.
2. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
3. Clean factory-glazed glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.
4. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

5. Protect window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written recommendations.

END OF SECTION 08 01 52 61

SECTION 08 05 13 00 - STEEL DOORS AND FRAMES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of material for steel doors and frames. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
 - a. Standard hollow metal doors and frames.
 - b. Custom hollow metal doors and frames.

C. Definitions

1. Minimum Thickness: Minimum thickness of base metal without coatings.
2. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.
3. Custom Hollow Metal Work: Hollow metal work fabricated according to ANSI/NAAMM-HMMA 861.

D. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: Include elevations, door edge details, frame profiles, metal thicknesses, preparations for hardware, and other details.
3. Samples for Verification: For each type of exposed finish required.
4. Schedule: Prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings.
5. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.
6. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

E. Quality Assurance

1. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure **OR** as close to neutral pressure as possible, **as directed**, according to NFPA 252 **OR** IBC Standard 716.5, **as directed**, or UL 10B **OR** UL 10C, **as directed**.
 - a. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 - b. Temperature-Rise Limit: Where indicated **OR** At vertical exit enclosures and exit passageways, **as directed**, provide doors that have a maximum transmitted temperature end point of not more than **450 deg F (250 deg C)** above ambient after 30 minutes of standard fire-test exposure.
2. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9 **OR** IBC Standard 716.5, **as directed**. Label each individual glazed lite.
3. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784 **OR** IBC Standard 716.5, **as directed**.

F. Delivery, Storage, And Handling

1. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
 - a. Provide additional protection to prevent damage to finish of factory-finished units.
2. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
3. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum **4-inch- (102-mm-)** high wood blocking. Do not store in a manner that traps excess humidity.
 - a. Provide minimum **1/4-inch (6-mm)** space between each stacked door to permit air circulation.

1.2 PRODUCTS

A. Materials

1. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
2. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
3. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum **A40 (ZF120) OR G60 (Z180) or A60 (ZF180)**, **as directed**, metallic coating.
4. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), **40Z (12G)** coating designation; mill phosphatized.
 - a. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
5. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
6. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.
7. Grout: ASTM C 476, except with a maximum slump of **4 inches (102 mm)**, as measured according to ASTM C 143/C 143M.
8. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with **6- to 12-lb/cu. ft. (96- to 192-kg/cu. m)** density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
9. Glazing: Comply with requirements in Division 08 Section "Glazing".
10. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for **15-mil (0.4-mm)** dry film thickness per coat.

B. Standard Hollow Metal Doors

1. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.
 - a. Design: Flush panel **OR** Embossed panel **OR** As indicated, **as directed**.
 - b. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.
 - 1) Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
 - 2) Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than **4.0 deg F x h x sq. ft./Btu (0.704 K x sq. m/W) OR 6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W) OR 12.3 deg F x h x sq. ft./Btu (2.166 K x sq. m/W)**, **as directed**, when tested according to ASTM C 1363.
 - a) Locations: Exterior doors and interior doors where indicated, **as directed**.

- c. Vertical Edges for Single-Acting Doors: Beveled edge **OR** Square edge **OR** Manufacturer's standard, **as directed**.
 - 1) Beveled Edge: **1/8 inch in 2 inches (3 mm in 50 mm)**.
 - d. Vertical Edges for Double-Acting Doors: Round vertical edges with **2-1/8-inch (54-mm)** radius.
 - e. Top and Bottom Edges: Closed with flush or inverted **0.042-inch- (1.0-mm-)** thick, end closures or channels of same material as face sheets.
 - f. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
2. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
 - a. Level 1 and Physical Performance Level C (Standard Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
 - 1) Width: **1-3/4 inches (44.5 mm) OR 1-3/8 inches (34.9 mm) OR** As indicated on Drawings, **as directed**.
 - b. Level 2 and Physical Performance Level B (Heavy Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
 - c. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless) **OR** Model 3 (Stile and Rail), **as directed**.
 - d. Level 4 and Physical Performance Level A (Maximum Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
 3. Interior Doors: Face sheets fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
 - a. Level 1 and Physical Performance Level C (Standard Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
 - 1) Width: **1-3/4 inches (44.5 mm) OR 1-3/8 inches (34.9 mm) OR** As indicated on Drawings, **as directed**.
 - b. Level 2 and Physical Performance Level B (Heavy Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
 - c. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless) **OR** Model 3 (Stile and Rail), **as directed**.
 - d. Level 4 and Physical Performance Level A (Maximum Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
 4. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
 5. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.
- C. Standard Hollow Metal Frames
1. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.
 2. Exterior Frames: Fabricated from metallic-coated steel sheet.
 - a. Fabricate frames with mitered or coped corners.
 - b. Fabricate frames as knocked down **OR** face welded **OR** full profile welded, **as directed**, unless otherwise indicated.
 - c. Frames for Level 1 Steel Doors: **0.042-inch- (1.0-mm-)** thick steel sheet.
 - d. Frames for Level 2 Steel Doors: **0.053-inch- (1.3-mm-)** thick steel sheet.
 - e. Frames for Level 3 Steel Doors: **0.053-inch- (1.3-mm-)** thick steel sheet.
 - f. Frames for Level 4 Steel Doors: **0.067-inch- (1.7-mm-)** thick steel sheet.
 3. Interior Frames: Fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated.
 - a. Fabricate frames with mitered or coped corners.
 - b. Fabricate frames as knocked down **OR** face welded **OR** full profile welded, **as directed**, unless otherwise indicated.
 - c. Fabricate knocked-down, drywall slip-on frames for in-place gypsum board partitions, **as directed**.

- d. Frames for Level 1 Steel Doors: 0.042-inch- (1.0-mm-) thick steel sheet.
 - e. Frames for Level 2 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
 - f. Frames for Level 3 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
 - g. Frames for Level 4 Steel Doors: 0.067-inch- (1.7-mm-) thick steel sheet.
 - h. Frames for Wood Doors: 0.042-inch- (1.0-mm-) OR 0.053-inch- (1.3-mm-) OR 0.067-inch- (1.7-mm-), **as directed**, thick steel sheet.
 - i. Frames for Borrowed Lights: 0.042-inch- (1.0-mm-) thick steel sheet OR 0.053-inch- (1.3-mm-) thick steel sheet OR 0.067-inch- (1.7-mm-) thick steel sheet OR Same as adjacent door frame, **as directed**.
4. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

D. Custom Hollow Metal Doors

- 1. General: Provide doors not less than 1-3/4 inches (44.5 mm) thick, of seamless hollow construction unless otherwise indicated. Construct doors with smooth surfaces without visible joints or seams on exposed faces. Comply with ANSI/NAAMM-HMMA 861.
- 2. Exterior Door Face Sheets: Fabricated from metallic-coated steel sheet, minimum 0.053 inch (1.3 mm) thick.
- 3. Interior Door Face Sheets: Fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated, minimum 0.042 inch (1.0 mm) thick.
- 4. Core Construction: Provide thermal-resistance-rated cores for exterior doors and interior doors where indicated, **as directed**.
 - a. Steel-Stiffened Core: 0.026-inch- (0.7-mm-) thick, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches (152 mm) apart, spot welded to face sheets a maximum of 5 inches (127 mm) o.c. Spaces filled between stiffeners with glass- or mineral-fiber insulation.
 - 1) Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
 - 2) Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 4.0 deg F x h x sq. ft./Btu (0.704 K x sq. m/W) OR 6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W), **as directed**, when tested according to ASTM C 1363.
- 5. Vertical Edges for Single-Acting Doors: Beveled 1/8 inch in 2 inches (3 mm in 50 mm).
- 6. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch (54-mm) radius.
- 7. Top and Bottom Channels: Closed with continuous channels, minimum 0.053 inch (1.3 mm) thick, of same material as face sheets and spot welded to both face sheets.
- 8. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 861 with reinforcing plates from same material as door face sheets.

E. Custom Hollow Metal Frames

- 1. General: Fabricate frames of construction indicated. Close contact edges of corner joints tight with faces mitered and stops butted or mitered. Continuously weld faces and soffits and finish faces smooth. Comply with ANSI/NAAMM-HMMA 861.
 - a. Door Frames for Openings 48 Inches (1219 mm) Wide or Less: Fabricated from 0.053-inch- (1.3-mm-) thick steel sheet.
 - b. Door Frames for Openings More Than 48 Inches (1219 mm) Wide: Fabricated from 0.067-inch- (1.7-mm-) thick steel sheet.
 - c. Sidelight and Transom Frames: Fabricated from same thickness material as adjacent door frame.
 - d. Borrowed-Light Frames: Fabricated from 0.053-inch- (1.3-mm-) thick steel sheet.
- 2. Exterior Frames: Formed from metallic-coated steel sheet.
- 3. Interior Frames: Fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated.
- 4. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 861 with reinforcing plates from same material as frame.

5. Head Reinforcement: Provide minimum **0.093-inch- (2.3-mm-)** thick, steel channel or angle stiffener for opening widths more than **48 inches (1219 mm)**.
- F. Frame Anchors
1. Jamb Anchors:
 - a. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than **0.042 inch (1.0 mm)** thick, with corrugated or perforated straps not less than **2 inches (50 mm)** wide by **10 inches (250 mm)** long; or wire anchors not less than **0.177 inch (4.5 mm)** thick.
 - b. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than **0.042 inch (1.0 mm)** thick.
 - c. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
 - d. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum **3/8-inch- (9.5-mm-)** diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
 2. Floor Anchors: Formed from same material as frames, not less than **0.042 inch (1.0 mm)** thick, and as follows:
 - a. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
 - b. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than **2-inch (50-mm)** height adjustment. Terminate bottom of frames at finish floor surface.
- G. Hollow Metal Panels
1. Provide hollow metal panels of same materials, construction, and finish as specified for adjoining hollow metal work.
- H. Stops And Moldings
1. Moldings for Glazed Lites in Doors: Minimum **0.032 inch (0.8 mm)** thick, fabricated from same material as door face sheet in which they are installed.
 2. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of **5/8 inch (16 mm)** high unless otherwise indicated.
 3. Loose Stops for Glazed Lites in Frames: Minimum **0.032 inch (0.8 mm)** thick, fabricated from same material as frames in which they are installed.
 4. Terminated Stops: Where indicated on interior door frames, terminate stops **6 inches (152 mm)** above finish floor with a 45-degree **OR** 90-degree, **as directed**, angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.
- I. Louvers
1. Provide louvers for interior doors, where indicated, that comply with SDI 111C, with blades or baffles formed of **0.020-inch- (0.5-mm-)** thick, cold-rolled steel sheet set into **0.032-inch- (0.8-mm-)** thick steel frame.
 - a. Sightproof Louver: Stationary louvers constructed with inverted V-shaped or Y-shaped blades.
 - b. Lightproof Louver: Stationary louvers constructed with baffles to prevent light from passing from one side to the other, any angle.
 - c. Fire-Rated Automatic Louvers: Louvers constructed with movable blades closed by actuating fusible link, and listed and labeled for use in fire-rated door assemblies of type and fire-resistance rating indicated by same testing and inspecting agency that established fire-resistance rating of door assembly.
- J. Accessories
1. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
 2. Ceiling Struts: Minimum **1/4-inch-thick by 1-inch- (6.4-mm-thick by 25.4-mm-)** wide steel.
 3. Grout Guards: Formed from same material as frames, not less than **0.016 inch (0.4 mm)** thick.

K. Fabrication

1. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
2. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117 **OR** ANSI/NAAMM-HMMA 861, **as directed**.
3. Hollow Metal Doors:
 - a. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
 - b. Glazed Lites: Factory cut openings in doors.
 - c. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum **3/4 inch (19 mm)** beyond edge of door on which astragal is mounted.
4. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - a. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 - b. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
 - c. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - d. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 - e. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
 - f. Jamb Anchors: Provide number and spacing of anchors as follows:
 - 1) Masonry Type: Locate anchors not more than **18 inches (457 mm)** from top and bottom of frame. Space anchors not more than **32 inches (813 mm)** o.c. and as follows:
 - a) Two anchors per jamb up to **60 inches (1524 mm)** high.
 - b) Three anchors per jamb from **60 to 90 inches (1524 to 2286 mm)** high.
 - c) Four anchors per jamb from **90 to 120 inches (2286 to 3048 mm)** high.
 - d) Four anchors per jamb plus 1 additional anchor per jamb for each **24 inches (610 mm)** or fraction thereof above **120 inches (3048 mm)** high.
 - 2) Stud-Wall Type: Locate anchors not more than **18 inches (457 mm)** from top and bottom of frame. Space anchors not more than **32 inches (813 mm)** o.c. and as follows:
 - a) Three anchors per jamb up to **60 inches (1524 mm)** high.
 - b) Four anchors per jamb from **60 to 90 inches (1524 to 2286 mm)** high.
 - c) Five anchors per jamb from **90 to 96 inches (2286 to 2438 mm)** high.
 - d) Five anchors per jamb plus 1 additional anchor per jamb for each **24 inches (610 mm)** or fraction thereof above **96 inches (2438 mm)** high.
 - e) Two anchors per head for frames above **42 inches (1066 mm)** wide and mounted in metal-stud partitions.
 - 3) Compression Type: Not less than two anchors in each jamb.
 - 4) Postinstalled Expansion Type: Locate anchors not more than **6 inches (152 mm)** from top and bottom of frame. Space anchors not more than **26 inches (660 mm)** o.c.
 - g. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - 1) Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - 2) Double-Door Frames: Drill stop in head jamb to receive two door silencers.

5. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.
6. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware".
 - a. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8 **OR** ANSI/NAAMM-HMMA 861.
 - b. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
 - c. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
 - d. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26.
7. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
 - a. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
 - b. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 - c. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
 - d. Provide loose stops and moldings on inside of hollow metal work.
 - e. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

L. Steel Finishes

1. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
 - a. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
2. Factory-Applied Paint Finish: Manufacturer's standard, complying with ANSI/SDI A250.3 for performance and acceptance criteria.
 - a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation

1. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
2. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 **OR** HMMA 840, **as directed**.
 - a. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - 1) At fire-protection-rated openings, install frames according to NFPA 80.
 - 2) Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - 3) Install frames with removable glazing stops located on secure side of opening.
 - 4) Install door silencers in frames before grouting.
 - 5) Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - 6) Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

- 7) Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.
 - b. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
 - 1) Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 - c. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
 - d. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
 - e. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
 - f. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 - g. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 - h. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.
 - i. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - 1) Squareness: Plus or minus **1/16 inch (1.6 mm)**, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - 2) Alignment: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs on a horizontal line parallel to plane of wall.
 - 3) Twist: Plus or minus **1/16 inch (1.6 mm)**, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - 4) Plumbness: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs at floor.
 3. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
 - a. Non-Fire-Rated Standard Steel Doors:
 - 1) Jambs and Head: **1/8 inch (3 mm)** plus or minus **1/16 inch (1.6 mm)**.
 - 2) Between Edges of Pairs of Doors: **1/8 inch (3 mm)** plus or minus **1/16 inch (1.6 mm)**.
 - 3) Between Bottom of Door and Top of Threshold: Maximum **3/8 inch (9.5 mm)**.
 - 4) Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum **3/4 inch (19 mm)**.
 - b. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
 - c. Smoke-Control Doors: Install doors according to NFPA 105 **OR** IBC Standard 716.5, **as directed**.
 4. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.
 - a. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than **9 inches (230 mm)** o.c. and not more than **2 inches (50 mm)** o.c. from each corner.
- B. Adjusting And Cleaning
1. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
 2. Remove grout and other bonding material from hollow metal work immediately after installation.

3. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
4. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 08 05 13 00

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SECTION 08 05 13 00a - 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 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. 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 Pattern: 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 NWDA 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 08 05 13 00a

SECTION 08 05 13 00b - FLUSH WOOD DOORS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of material for flush wood doors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
 - a. Solid-core doors and transom panels with wood-veneer, medium-density-overlay, hardboard or MDF, and plastic-laminate faces.
 - b. Hollow-core doors with wood-veneer, hardboard or MDF, and plastic-laminate faces.
 - c. Shop priming and Factory finishing flush wood doors.
 - d. Factory fitting flush wood doors to frames and factory machining for hardware.

C. Submittals

1. Product Data: For each type of door indicated. Include factory-finishing specifications.
2. LEED Submittals:
 - a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that flush wood doors comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
 - 1) Include statement indicating costs for each certified wood product.
 - b. Product Data for Credit EQ 4.4: For adhesives and composite wood products, documentation indicating that product contains no urea formaldehyde.
3. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
 - a. Indicate dimensions and locations of mortises and holes for hardware.
 - b. Indicate dimensions and locations of cutouts.
 - c. Indicate requirements for veneer matching.
 - d. Indicate doors to be factory finished and finish requirements.
 - e. Indicate fire-protection ratings for fire-rated doors.
4. Samples: For plastic-laminate door faces and factory-finished doors.

D. Quality Assurance

1. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
2. Quality Standard: In addition to requirements specified, comply with AWI's "Architectural Woodwork Quality Standards Illustrated" **OR** WDMA I.S.1-A, "Architectural Wood Flush Doors" **OR** WI's "Manual of Millwork", **as directed**.
3. Forest Certification: Provide doors made with cores **OR** veneers **OR** not less than 70 percent of wood products **OR** all wood products, **as directed**, obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
4. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure **OR** as close to neutral pressure as possible, **as directed**, according to NFPA 252 **OR** IBC Standard 716.5 **OR** UL 10B **OR** UL 10C, **as directed**.
 - a. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

- b. Temperature-Rise Limit: Where indicated **OR** At vertical exit enclosures and exit passageways, **as directed**, provide doors that have a maximum transmitted temperature end point of not more than **450 deg F (250 deg C)** above ambient after 30 minutes of standard fire-test exposure.
- 5. Preinstallation Conference: Conduct conference at Project site.
- E. Delivery, Storage, And Handling
 - 1. Comply with requirements of referenced standard and manufacturer's written instructions.
 - 2. Package doors individually in plastic bags or cardboard cartons **OR** cardboard cartons and wrap bundles of doors in plastic sheeting, **as directed**.
 - 3. Mark each door on bottom **OR** top and bottom, **as directed**, rail with opening number used on Shop Drawings.
- F. Warranty
 - 1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 - a. Warranty Period for Solid-Core Exterior Doors: Two **OR** Five, **as directed**, years from date of Final Completion.
 - b. Warranty Period for Solid-Core Interior Doors: Life of installation.
 - c. Warranty Period for Hollow-Core Interior Doors: One **OR** Two, **as directed**, year(s) from date of Final Completion.

1.2 PRODUCTS

- A. Door Construction, General
 - 1. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.
 - 2. WDMA I.S.1-A Performance Grade:
 - a. Heavy Duty unless otherwise indicated.
 - b. Extra Heavy Duty: Classrooms, public toilets, janitor's closets, assembly spaces, exits, patient rooms, and where indicated.
 - c. Standard Duty: Closets (not including janitor's closets), private toilets, and where indicated.
 - 3. Particleboard-Core Doors:
 - a. Particleboard:
 - 1) ANSI A208.1, Grade LD-1 **OR** Grade LD-2, **as directed**, made with binder containing no urea-formaldehyde resin, **as directed**.
 - OR**
 - Straw-based particleboard complying with ANSI A208.1, Grade LD-2 or M-2, except for density.
 - b. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
 - c. Provide doors with glued-wood-stave **OR** structural-composite-lumber, **as directed**, cores instead of particleboard cores for doors indicated to receive exit devices.
 - 4. Structural-Composite-Lumber-Core Doors:
 - a. Structural Composite Lumber: WDMA I.S.10.
 - 1) Screw Withdrawal, Face: **700 lbf (3100 N)**.
 - 2) Screw Withdrawal, Edge: **400 lbf (1780 N)**.
 - 5. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
 - a. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.

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- f. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions, **as directed**.
 - g. Room Match:
 - 1) Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by **10 feet (3 m) OR 20 feet (6 m), as directed**, or more.
OR
 Provide door faces of compatible color and grain within each separate room or area of building.
 - h. Transom Match: Continuous match **OR** End match **OR** As indicated, **as directed**.
 - i. Blueprint Match: Where indicated, provide doors with faces produced from same flitches as adjacent wood paneling and arranged to provide blueprint match with wood paneling. Comply with requirements in Division 06 Section(s) "Interior Architectural Woodwork" **OR** "Wood Paneling", **as directed**.
 - j. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Same species as faces or a compatible species **OR** Same species as faces **OR** Applied wood-veneer edges of same species as faces and covering edges of faces **OR** Applied wood edges of same species as faces and covering edges of crossbands, **as directed**.
 - k. Core: Particleboard **OR** Glued wood stave **OR** Nonglued wood stave **OR** Structural composite lumber, **as directed**.
 - l. Construction:
 - 1) Five **OR** Five or seven, **as directed**, plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering. Faces are bonded to core using a hot press, **as directed**.
OR
 Seven plies, either bonded or nonbonded construction.
3. Interior Hollow-Core Doors:
- a. Grade: Premium, with Grade AA faces **OR** Premium, with Grade A faces **OR** Custom (Grade A faces) **OR** Economy (Grade B faces), **as directed**.
 - b. Species: Anigre **OR** Select white ash **OR** Figured select white ash **OR** Select white birch **OR** Cherry **OR** Select red gum **OR** Figured select red gum **OR** Select white maple **OR** Red oak **OR** Persimmon **OR** Sapele **OR** Sycamore **OR** Walnut **OR** White oak **OR** Ucuuba (Virola Duckei) **OR** Cupiuba (Goupia glabra), **as directed**.
 - c. Cut: Rotary cut **OR** Plain sliced (flat sliced) **OR** Quarter sliced **OR** Rift cut, **as directed**.
 - d. Match between Veneer Leaves: Book **OR** Slip **OR** Pleasing, **as directed**, match.
 - e. Assembly of Veneer Leaves on Door Faces: Center-balance **OR** Balance **OR** Running, **as directed**, match.
 - f. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions, **as directed**.
 - g. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Same species as faces or a compatible species **OR** Same species as faces **OR** Applied wood-veneer edges of same species as faces and covering edges of faces **OR** Applied wood edges of same species as faces and covering edges of crossbands, **as directed**.
 - h. Construction: Seven plies.
- C. Doors For Opaque Finish
- 1. Exterior Solid-Core Doors:
 - a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
 - b. Faces: Medium-density overlay **OR** Any closed-grain hardwood of mill option, **as directed**.
 - 1) Apply medium-density overlay to standard-thickness, closed-grain, hardwood face veneers **OR** directly to high-density hardboard crossbands, **as directed**.
 - c. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Any closed-grain hardwood.
 - d. Core: Particleboard **OR** Glued wood stave **OR** Structural composite lumber, **as directed**.

- e. Construction: Five **OR** Five or seven, **as directed**, plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering. Faces are bonded to core using a hot press, **as directed**.
- f. Adhesives: Type I per WDMA TM-6.
2. Interior Solid-Core Doors:
 - a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
 - b. Faces: Medium-density overlay **OR** Any closed-grain hardwood of mill option **OR** Hardboard or MDF, **as directed**.
 - 1) Apply medium-density overlay to standard-thickness, closed-grain, hardwood face veneers **OR** directly to high-density hardboard crossbands, **as directed**.
 - 2) Hardboard Faces: AHA A135.4, Class 1 (tempered) or Class 2 (standard).
 - 3) MDF Faces: ANSI A208.2, Grade 150 or 160.
 - c. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Any closed-grain hardwood.
 - d. Core: Particleboard **OR** Glued wood stave **OR** Nonglued wood stave **OR** Structural composite lumber, **as directed**.
 - e. Construction:
 - 1) Three **OR** Five **OR** Five or seven, **as directed**, plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering. Faces are bonded to core using a hot press, **as directed**.
OR
Three **OR** Seven, **as directed**, plies, either bonded or nonbonded construction.
3. Interior Hollow-Core Doors:
 - a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
 - b. Faces: Medium-density overlay **OR** Any closed-grain hardwood of mill option **OR** Hardboard or MDF, **as directed**.
 - 1) Hardboard Faces: AHA A135.4, Class 1 (tempered) or Class 2 (standard).
 - 2) MDF Faces: ANSI A208.2, Grade 150 or 160.
 - c. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Any closed-grain hardwood.
 - d. Construction: Three **OR** Seven, **as directed**, plies.
- D. Plastic-Laminate-Faced Doors
 1. Interior Solid-Core Doors:
 - a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
 - b. Plastic-Laminate Faces: High-pressure decorative laminates complying with NEMA LD 3, Grade HGS **OR** Grade HSH, **as directed**.
 - c. Colors, Patterns, and Finishes: As indicated **OR** As selected from laminate manufacturer's full range of products, **as directed**.
 - d. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Hardwood edges for staining to match faces **OR** Hardwood edges for painting **OR** Plastic laminate that matches faces, applied before faces **OR** Impact-resistant polymer edging, applied after faces, **as directed**.
 - 1) Polymer Edging Color: Beige **OR** Brown **OR** Same color as faces, **as directed**.
 - e. Core: Particleboard **OR** Glued wood stave **OR** Structural composite lumber, **as directed**.
 - f. Construction:
 - 1) Three plies. Stiles and rails are bonded to core, then entire unit abrasive planed before faces are applied. Faces are bonded to core using a hot press, **as directed**.
OR
Five plies. Stiles and rails are bonded to core, then entire unit abrasive planed before faces and crossbands are applied. Faces are bonded to core using a hot press, **as directed**.
 2. Interior Hollow-Core Doors:
 - a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
 - b. Plastic-Laminate Faces: High-pressure decorative laminates complying with NEMA LD 3, Grade HGS **OR** Grade HSH, **as directed**.
 - c. Colors, Patterns, and Finishes: As indicated **OR** As selected from laminate manufacturer's full range of products, **as directed**.

- d. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Hardwood edges for staining to match faces **OR** Hardwood edges for painting **OR** Plastic laminate that matches faces, applied before faces **OR** Impact-resistant polymer edging, applied after faces, **as directed**.
 1) Polymer Edging Color: Beige **OR** Brown **OR** Same color as faces, **as directed**.
- e. Construction: Plastic-laminate faces glued directly to core.

E. Louvers And Light Frames

- 1. Wood Louvers: Door manufacturer's standard solid-wood louvers unless otherwise indicated.
 - a. Wood Species: Same species as door faces **OR** Species compatible with door faces **OR** Any closed-grain hardwood, **as directed**.
- 2. Metal Louvers:
 - a. Blade Type: Vision-proof, inverted V **OR** Vision-proof, inverted Y **OR** Darkroom-type, double inverted V, **as directed**.
 - b. Metal and Finish:
 - 1) Hot-dip galvanized steel, 0.040 inch (1.0 mm) thick, factory primed for paint finish **OR** with baked-enamel- or powder-coated finish, **as directed**.
OR
 Extruded aluminum with Class II, clear anodic finish, AA-M12C22A31.
OR
 Extruded aluminum with light bronze **OR** medium bronze **OR** dark bronze **OR** black, **as directed**, Class II, color anodic finish, AA-M12C22A32/A34.
- 3. Louvers for Fire-Rated Doors: Metal louvers with fusible link and closing device, listed and labeled for use in doors with fire-protection rating of 1-1/2 hours and less.
 - a. Metal and Finish: Hot-dip galvanized steel, 0.040 inch (1.0 mm) thick, factory primed for paint finish **OR** with baked-enamel- or powder-coated finish, **as directed**.
- 4. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads as follows unless otherwise indicated.
 - a. Wood Species: Same species as door faces **OR** Species compatible with door faces **OR** Any closed-grain hardwood, **as directed**.
 - b. Profile: Flush rectangular beads **OR** Recessed tapered beads **OR** Recessed tapered beads with exposed banding **OR** Lipped tapered beads **OR** Manufacturer's standard shape, **as directed**.
 - c. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.
- 5. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire-protection rating indicated. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.
- 6. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; factory primed for paint finish **OR** with baked-enamel- or powder-coated finish, **as directed**; and approved for use in doors of fire-protection rating indicated.

F. Fabrication

- 1. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 - a. Comply with requirements in NFPA 80 for fire-rated doors.
- 2. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
 - a. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
 - b. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

3. Transom and Side Panels: Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.
 - a. Fabricate door and transom panels with full-width, solid-lumber, rabbeted, **as directed**, meeting rails. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.
 4. Openings: Cut and trim openings through doors in factory.
 - a. Light Openings: Trim openings with moldings of material and profile indicated.
 - b. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Division 08 Section "Glazing".
 - c. Louvers: Factory install louvers in prepared openings.
 5. Exterior Doors: Factory treat exterior doors with water repellent after fabrication has been completed but before shop priming **OR** factory finishing, **as directed**.
 - a. Flash top of outswinging doors (with manufacturer's standard metal flashing).
- G. Shop Priming
1. Doors for Opaque Finish: Shop prime doors with one coat of wood primer specified in Division 09 Section(s) "Exterior Painting" OR "Interior Painting", **as directed**. Seal all four edges, edges of cutouts, and mortises with primer.
 2. Doors for Transparent Finish: Shop prime doors with stain (if required), other required pretreatments, and first coat of finish as specified in Division 09 Section(s) "Exterior Painting" OR "Interior Painting" OR "Staining And Transparent Finishing", **as directed**. Seal all four edges, edges of cutouts, and mortises with first coat of finish.
- H. Factory Finishing
1. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 - a. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom **OR** top and bottom, **as directed**, edges, edges of cutouts, and mortises.
 2. Finish doors at factory.
OR
Finish doors at factory that are indicated to receive transparent finish. Field finish doors indicated to receive opaque finish.
OR
Finish doors at factory where indicated in schedules or on Drawings as factory finished.
 3. Transparent Finish:
 - a. Grade: Premium **OR** Custom, **as directed**.
 - b. Finish:
 - 1) AWI conversion varnish **OR** catalyzed polyurethane, **as directed**, system.
OR
WDMA TR-4 conversion varnish **OR** TR-6 catalyzed polyurethane, **as directed**.
OR
WI System 4 clear conversion varnish **OR** 5 catalyzed polyurethane **OR** 8 UV-curable coating, **as directed**.
 - c. Staining: Match sample **OR** As selected from manufacturer's full range **OR** None required, **as directed**.
 - d. Effect: Open-grain finish **OR** Filled finish **OR** Semifilled finish, produced by applying an additional finish coat to partially fill the wood pores, **as directed**.
 - e. Sheen: Satin **OR** Semigloss, **as directed**.
 4. Opaque Finish:
 - a. Grade: Premium **OR** Custom, **as directed**.
 - b. Finish:
 - 1) AWI conversion varnish **OR** catalyzed polyurethane, **as directed**, system.
OR
WDMA OP-4 conversion varnish **OR** OP-6 catalyzed polyurethane, **as directed**.

OR

WI System 4 conversion varnish **OR** 5 catalyzed polyurethane **OR** 8 UV-curable coating, **as directed**.

- c. Color: Match sample **OR** As selected from manufacturer's full range, **as directed**.
- d. Sheen: Satin **OR** Semigloss **OR** Gloss, **as directed**.

1.3 EXECUTION

A. Installation

1. Hardware: For installation, see Division 08 Section "Door Hardware".
2. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
 - a. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
3. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
 - a. Clearances: Provide **1/8 inch (3.2 mm)** at heads, jambs, and between pairs of doors. Provide **1/8 inch (3.2 mm)** from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide **1/4 inch (6.4 mm)** from bottom of door to top of threshold unless otherwise indicated.
 - 1) Comply with NFPA 80 for fire-rated doors.
 - b. Bevel non-fire-rated doors **1/8 inch in 2 inches (3-1/2 degrees)** at lock and hinge edges.
 - c. Bevel fire-rated doors **1/8 inch in 2 inches (3-1/2 degrees)** at lock edge; trim stiles and rails only to extent permitted by labeling agency.
4. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
5. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

B. Adjusting

1. Operation: Rehang or replace doors that do not swing or operate freely.
2. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 08 05 13 00b

SECTION 08 05 13 00c - SOUND CONTROL DOORS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of material for sound-control door assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
 - a. Steel sound-control doors.
 - b. Wood sound-control doors.
 - c. Steel frames and sound-control seals.

C. Submittals

1. Product Data: For each type of product indicated. Include sound ratings, construction details, material descriptions, core descriptions, fire-resistance rating, temperature-rise ratings, and finishes.
2. LEED Submittals:
 - a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood doors comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body, **as directed**.
 - b. Product Data for Credit EQ 4.4: For adhesives and composite wood products, indicating that product contains no urea formaldehyde.
3. Shop Drawings: Include the following:
 - a. Elevations of each door design.
 - b. Details of sound-control seals, door bottoms, and thresholds.
 - c. Details of doors, including vertical and horizontal edge details and metal thicknesses.
 - d. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - e. Locations of reinforcement and preparations for hardware.
 - f. Details of each different wall opening condition.
 - g. Details of anchorages, joints, field splices, and connections.
 - h. Details of accessories.
 - i. Details of moldings, removable stops, and glazing.
 - j. Details of conduit and preparations for power, signal, and control systems.
4. Samples:
 - a. Finishes: For each type of exposed finish required, prepared on Samples of not less than **3 by 5 inches (75 by 125 mm)**.
 - b. Doors: Include section of vertical-edge, top, and bottom construction; automatic door bottom or gasket; core construction; glazing; and hinge and other applied hardware reinforcement.
 - c. Frames: Include profile, corner joint, floor and wall anchors, and seals. Include separate section showing fixed sound panels if applicable.
5. Schedule: Provide a schedule of sound-control door assemblies prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with the Door Hardware Schedule.
6. Qualification Data: For qualified Installer, manufacturer, and acoustical testing agency.
7. Product Certificates: For each type of sound-control door assembly, from manufacturer.
8. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of sound-control door assembly.
9. Field quality-control reports.
10. Maintenance Data: For sound-control door assemblies to include in maintenance manuals.

11. Warranty: Samples of special warranty.

D. Quality Assurance

1. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
2. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
3. Acoustical Testing Agency Qualifications: An independent agency accredited as an acoustical laboratory according to the National Voluntary Laboratory Accreditation Program of NIST.
4. Source Limitations: Obtain sound-control door assemblies, including doors, frames, sound-control seals, hinges (when integral for sound control), thresholds, and other items essential for sound control, from single source from single manufacturer.
5. Sound Rating: Provide sound-control door assemblies identical to those of assemblies tested as sound-retardant units by an acoustical testing agency, and have the following minimum rating:
 - a. STC Rating: As indicated on Drawings **OR** As indicated in the Door Schedule, **as directed**, as determined by ASTM E 413 when tested in an operable condition according to ASTM E 90 and ASTM E 1408.
6. Forest Certification: Provide doors made with cores **OR** veneers **OR** not less than 70 percent of wood products **OR** all wood products, **as directed**, obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
7. Fire-Rated Door Assemblies: Assemblies listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
 - a. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
8. Smoke- and Draft-Control Door Assemblies: Where indicated **OR** At corridors, smoke barriers, and smoke partitions, **as directed**, provide assemblies tested according to UL 1784.
 - a. Air-Leakage Rate: Maximum air leakage of **0.3 cfm/sq. ft. (3 cu. m/m x sq. m)** at the tested pressure differential of **0.3-inch wg (75 Pa)** of water.
9. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling

1. Deliver doors and frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
 - a. Provide additional protection to prevent damage to finish of factory-finished wood doors.
2. Shipping Spreaders: Deliver welded frames with two removable spreader bars across bottom of frames, tack welded or mechanically attached to jambs and mullions.
3. Store doors and frames under cover at Project site. Place units in a vertical position with heads up, spaced by blocking, on minimum **4-inch- (100-mm-)** high, wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber.
 - a. If wrappers on doors become wet, remove cartons immediately. Provide a minimum of **1/4-inch (6-mm)** space between each stacked door to permit air circulation.

F. Project Conditions

1. Environmental Limitations: Do not deliver or install wood sound-control wood doors until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
2. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

G. Coordination

1. Coordinate installation of anchorages for sound-control door assemblies. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

H. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sound-control door assemblies that fail in materials or workmanship within specified warranty period.
 - a. Failures include, but are not limited to, the following:
 - 1) Failure to meet sound rating requirements.
 - 2) Faulty operation of sound seals.
 - 3) Deterioration of metals, metal finishes, and other materials beyond normal use or weathering.
 - 4) Wood doors that are warped (bow, cup, or twist) more than **1/4 inch (6 mm)** in a **42-by-84-inch (1067-by-2134-mm)** section, or show telegraphing of core construction in face veneers exceeding **0.01 inch in a 3-inch (0.25 mm in a 75-mm)** span.
 - b. Warranty Period for Steel Doors: Five years from date of Final Completion.
 - c. Warranty Period for Wood Doors: Two years from date of Final Completion.

1.2 PRODUCTS

A. Steel Sound-Control Doors

1. Description: Provide flush-design sound-control doors, **1-3/4 inches (44 mm)** thick, of seamless construction; with manufacturer's standard sound-retardant core as required to provide STC **OR** STC and fire, **as directed**, rating indicated. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges. Fabricate according to ANSI/NAAMM-HMMA 865.
 - a. Exterior Doors: Fabricate from metallic-coated steel sheet **0.052-inch (1.32-mm)** nominal thickness, or thicker as required to provide STC rating indicated.
 - b. Interior Doors: Fabricate from cold-rolled steel sheet unless otherwise indicated, **0.048-inch (1.21-mm)** nominal thickness, or thicker as required to achieve STC rating indicated.
 - c. Loose Stops for Glazed Lites in Doors: Same material as face sheets.
 - d. Top and Bottom Channels: Closed with continuous channels of same material as face sheets, spot welded to face sheets not more than **6 inches (150 mm)** o.c.
 - e. Hardware Reinforcement: Same material as face sheets.
2. Materials:
 - a. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
 - b. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
 - c. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B, with **G60 (Z180)** zinc (galvanized) or **A40 (ZF120)** zinc-iron-alloy (galvannealed) coating designation.
 - d. Glazing: As required by sound-control door assembly manufacturer to comply with sound-control **OR** sound-control and fire-rated-door labeling, **as directed**, requirements.
3. Finishes:
 - a. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
 - 1) Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
 - b. Factory-Applied Paint Finish: Manufacturer's standard primer and finish coats, complying with ANSI/SDI A250.3 for performance and acceptance criteria.

- 1) Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

B. Wood Sound-Control Doors

1. Description: Provide flush-design sound-control doors, **1-3/4 inches (44 mm)** thick; with manufacturer's standard sound-retardant core as required to provide **STC OR** **STC** and fire, **as directed**, rating indicated. Fabricate according to WDMA 1.S.1-A.
2. Materials: Comply with Division 08 Section(s) "Flush Wood Doors" OR "Stile And Rail Wood Doors", **as directed**, for grade, faces, veneer matching, fabrication, finishing, and other requirements unless otherwise indicated.
 - a. Glazing: As required by sound-control door assembly manufacturer to comply with sound-control **OR** sound-control and fire-rated-door labeling, **as directed**, requirements.
3. Finishes:
 - a. Factory finish sound-control wood doors to match doors specified in Division 08 Section(s) "Flush Wood Doors" OR "Stile And Rail Wood Doors", **as directed**.

C. Sound-Control Panels

1. Provide sound-control panels of same materials, construction, sound rating, and finish as specified for adjoining sound-control steel **OR** wood, **as directed**, doors.

D. Sound-Control Frames

1. Description: Fabricate sound-control door frames with corners mitered, reinforced, and continuously welded full depth and width of frame. Fabricate according to ANSI/NAAMM-HMMA 865.
 - a. Weld frames according to NAAMM-HMMA 820.
 - b. Exterior Frames: Fabricate from metallic-coated steel sheet **0.079-inch (2.01-mm)** nominal thickness, or thicker as required to provide STC rating indicated.
 - c. Interior Frames: Fabricate from cold-rolled steel sheet unless otherwise indicated, **0.075-inch (1.90-mm)** nominal thickness, or thicker as required to provide STC rating indicated.
 - d. Sound-Control Panel Stops: Formed integral with frames, a minimum of **5/8 inch (16 mm)** high, unless otherwise indicated.
 - e. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 865 of same material as face sheets.
 - f. Head Reinforcement: Reinforce frames with metallic-coated steel channel or angle stiffener, **0.108-inch (2.74-mm)** nominal thickness, welded to head.
 - g. Jamb Anchors:
 - 1) Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than **0.064-inch (1.63-mm)** nominal thickness metallic-coated steel with corrugated or perforated straps not less than **2 inches (50 mm)** wide by **10 inches (250 mm)** long; or wire anchors not less than **0.156 inch (4.0 mm)** thick.
 - 2) Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than **0.048-inch (1.21-mm)** nominal thickness uncoated steel unless otherwise indicated.
 - 3) Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum **3/8-inch (9.5-mm-)** diameter, metallic-coated steel bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
 - h. Floor Anchors: Not less than **0.079-inch (2.01-mm)** nominal thickness metallic-coated steel, and as follows:
 - 1) Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
 - 2) Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than **2-inch (50-mm)** height adjustment. Terminate bottom of frames at finish floor surface.
 - i. Ceiling Struts: Minimum **3/8-inch-thick by 2-inch- (9.5-mm-thick by 50-mm-)** wide uncoated steel unless otherwise indicated.
 - j. Plaster Guards: Metallic-coated steel sheet, not less than **0.026 inch (0.6 mm)** thick.

2. Materials:
 - a. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
 - b. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
 - c. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B, with **G60 (Z180)** zinc (galvanized) or **A40 (ZF120)** zinc-iron-alloy (galvannealed) coating designation.
 - d. Supports and Anchors: After fabricating, galvanize units to be built into exterior walls according to ASTM A 153/A 153M, Class B.
 - e. Inserts, Bolts, and Fasteners: Provide items to be built into exterior walls, hot-dip galvanized according to ASTM A 153/A 153M or ASTM F 2329.
 - f. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching sound-control door frames of type indicated.
 - g. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers.
3. Finishes:
 - a. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
 - 1) Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
 - b. Factory-Applied Paint Finish: Manufacturer's standard primer and finish coats, complying with ANSI/SDI A250.3 for performance and acceptance criteria.
 - 1) Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

E. Sound-Control Hardware

1. Description: Provide manufacturer's standard sound-control system, including head and jamb seals, door bottoms, cam-lift hinges, and thresholds, as required by testing to achieve STC **OR** STC and fire, **as directed**, rating indicated.
 - a. Compression Seals: One-piece units; consisting of closed-cell sponge neoprene seal held in place by metal retainer; with retainer cover of same material as door frame; attached to door frame with concealed screws.
OR
Magnetic Seals: One-piece units; consisting of closed-cell sponge neoprene seal and resiliently mounted magnet held in place by metal retainer; with retainer cover of same material as door frame; attached to door frame with concealed screws.
 - b. Automatic Door Bottoms: Neoprene or silicone gasket, held in place by metal housing, that automatically drops to form seal when door is closed; mounted to bottom edge of door with screws.
 - 1) Mounting: Mortised or semimortised into bottom of door or surface mounted on face of door as required by testing to achieve STC rating indicated.
OR
Door Bottoms: Neoprene or silicone gasket held in place by metal housing; mortised into bottom edge of door.
 - c. Cam-Lift Hinges: Full-mortise template type that raises door **1/2 inch (13 mm)** when door is fully open; with hardened pin; fabricated from stainless steel.
 - d. Thresholds: Flat, smooth, unfluted type as recommended by manufacturer; fabricated from aluminum **OR** stainless steel **OR** solid wood matching wood door faces, **as directed**.
 - 1) Finish: Clear **OR** Color, **as directed**, anodic finish.
 - 2) Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.
2. Other Hardware: Comply with requirements in Division 08 Section "Door Hardware".

F. Sound-Control Accessories

1. Glazing: Comply with requirements in Division 08 Section "Glazing"
2. Grout: Comply with ASTM C 476, with a slump of not more than **4 inches (102 mm)** as measured according to ASTM C 143/C 143M.
3. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for **15-mil (0.4-mm)** dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

G. Fabrication

1. Sound-Control Steel Door Fabrication: Sound-control doors to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal.
 - a. Seamless Edge Construction: Fabricate doors with faces joined at vertical edges by welding; welds shall be ground, filled, and dressed to make them invisible and to provide a smooth, flush surface.
 - b. Exterior Doors: Close top edges flush and seal joints against water penetration. Provide weep-hole openings in bottom of exterior doors to permit moisture to escape.
 - c. Glazed Lites: Factory install glazed lites according to requirements of tested assembly to achieve STC rating indicated. Provide fixed stops and moldings welded on secure side of door.
 - d. Hardware Preparation: Factory prepare sound-control doors to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in "Door Hardware".
 - 1) Reinforce doors to receive nontemplated mortised and surface-mounted door hardware.
 - 2) Locate door hardware as indicated, or if not indicated, according to NAAMM-HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."
 - e. Tolerances: Fabricate doors to tolerances indicated in ANSI/NAAMM-HMMA 865.
2. Sound-Control Wood Door Fabrication: Factory fit doors to suit frame-opening sizes indicated, with uniform clearances and bevels according to referenced quality standard, unless otherwise indicated. Comply with final door hardware schedules and hardware templates.
 - a. Comply with clearance requirements in NFPA 80 for fire-rated doors.
 - b. Locate door hardware as indicated, or if not indicated, according to DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
 - 1) Coordinate measurements of hardware mortises in steel frames to verify dimensions and alignment before factory machining.
3. Sound-Control Frame Fabrication: Fabricate sound-control frames to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
 - a. Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated from same thickness metal as frames.
 - b. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - c. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
 - d. Jamb Anchors: Provide number and spacing of anchors as follows:
 - 1) Masonry Type: Locate anchors not more than **18 inches (457 mm)** from top and bottom of frame. Space anchors not more than **32 inches (813 mm)** o.c. and as follows:
 - a) Two anchors per jamb up to **60 inches (1524 mm)** in height.
 - b) Three anchors per jamb from **60 to 90 inches (1524 to 2286 mm)** in height.

- c) Four anchors per jamb from 90 to 96 inches (2286 to 2438 mm) in height.
 - d) Four anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof more than 96 inches (2438 mm) in height.
- 2) Stud Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
 - a) Three anchors per jamb up to 60 inches (1524 mm) in height.
 - b) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) in height.
 - c) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) in height.
 - d) Five anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof more than 96 inches (2438 mm) in height.
 - e) Two anchors per head for frames more than 42 inches (1066 mm) wide and mounted in metal stud partitions.
- 3) Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.
- e. Head Reinforcement: For frames more than 48 inches (1219 mm) wide, provide continuous head reinforcement for full width of opening, welded to back of frame at head.
- f. Hardware Preparation: Factory prepare sound-control frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware".
 - 1) Reinforce frames to receive nontemplated mortised and surface-mounted door hardware.
 - 2) Locate hardware as indicated, or if not indicated, according to NAAMM-HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."
- g. Plaster Guards: Weld guards to frame at back of hardware cutouts and glazing-stop screw and sound-control seal preparations to close off interior of openings in frames to be grouted.
- h. Tolerances: Fabricate frames to tolerances indicated in ANSI/NAAMM-HMMA 865.

1.3 EXECUTION

A. Examination

- 1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of sound-control door assemblies.
- 2. Examine roughing-in for embedded and built-in anchors to verify actual locations of sound-control door frame connections before frame installation.
- 3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation

- 1. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- 2. Prior to installation and with installation spreaders in place, adjust and securely brace sound-control door frames to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.

3. Drill and tap doors and frames to receive nontemplated mortised and surface-mounted door hardware.

C. Installation

1. General: Install sound-control door assemblies plumb, rigid, properly aligned, and securely fastened in place; comply with manufacturer's written instructions.
2. Frames: Install sound-control door frames in sizes and profiles indicated.
 - a. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - 1) At fire-rated openings, install frames according to NFPA 80.
 - 2) At openings requiring smoke and draft control, install frames according to NFPA 105.
 - 3) Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, and dress; make splice smooth, flush, and invisible on exposed faces.
 - 4) Install sound-control frames with removable glazing stops located on secure side of opening.
 - 5) Remove temporary braces only after frames or bucks have been properly set and secured.
 - 6) Check squareness, twist, and plumbness of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - 7) Apply corrosion-resistant coatings coating to backs of frames to be filled with mortar, grout, and plaster containing antifreezing agents.
 - b. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor and secure with postinstalled expansion anchors.
 - 1) Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors, if so indicated and approved on Shop Drawings.
 - c. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
 - d. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 - e. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 - f. Ceiling Struts: Extend struts vertically from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.
 - g. Grouted Frames: Solidly fill space between frames and substrate with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
 - h. Installation Tolerances: Adjust sound-control door frames for squareness, alignment, twist, and plumbness to the following tolerances:
 - 1) Squareness: Plus or minus **1/16 inch (1.6 mm)**, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - 2) Alignment: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs on a horizontal line parallel to plane of wall.
 - 3) Twist: Plus or minus **1/16 inch (1.6 mm)**, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - 4) Plumbness: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs on a perpendicular line from head to floor.
3. Doors: Fit sound-control doors accurately in frames, within clearances indicated below. Shim as necessary.

- a. Non-Fire-Rated Doors: Fit non-fire-rated doors accurately in frames with the following clearances:
 - 1) Jambs: 1/8 inch (3 mm).
 - 2) Head with Butt Hinges: 1/8 inch (3 mm).
 - 3) Head with Cam-Lift Hinges: As required by manufacturer, but not more than 3/8 inch (9.5 mm).
 - 4) Sill: Manufacturer's standard.
 - 5) Between Edges of Pairs of Doors: 1/8 inch (3 mm).
 - b. Fire-Rated Doors: Install fire-rated doors with clearances according to NFPA 80.
 4. Sound-Control Seals: Where seals have been prefitted and preinstalled in the factory and subsequently removed for shipping, reinstall seals and adjust according to manufacturer's written instructions.
 5. Cam-Lift Hinges: Install hinges according to manufacturer's written instructions.
 6. Thresholds: Set thresholds in full bed of sealant complying with requirements in Division 7 Section "Joint Sealants."
 7. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with sound-control door assembly manufacturer's written instructions.
 - a. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c., and not more than 2 inches (50 mm) o.c. from each corner.
- D. Field Quality Control
 1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
 2. Testing Services: Acoustical testing and inspecting agency shall select one sound-control door at random from sound-control door assemblies that are completely installed and perform testing for verification that assembly complies with STC rating requirements.
 - a. Field tests shall be conducted according to ASTM E 336, with results calculated according to ASTM E 413. Acceptable field STC values shall be within 5 dB of laboratory STC values.
 - b. Inspection Report: Acoustical testing agency shall submit report in writing to the Owner and Contractor within 24 hours after testing.
 - c. If tested door fails, replace or rework all sound-control door assemblies to bring them into compliance at Contractor's expense.
 - 1) Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 3. Prepare test and inspection reports.
- E. Adjusting And Cleaning
 1. Final Adjustments: Check and adjust seals, door bottoms, and other sound-control hardware items right before final inspection. Leave work in complete and proper operating condition.
 2. Remove and replace defective work, including defective or damaged sound seals and doors and frames that are warped, bowed, or otherwise unacceptable.
 - a. Adjust gaskets, gasket retainers, and retainer covers to provide contact required to achieve STC rating.
 3. Clean grout off sound-control door frames immediately after installation.
 4. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.
 5. Metallic-Coated Surfaces: Clean abraded areas of doors and repair with galvanizing repair paint according to manufacturer's written instructions.

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Task	Specification	Specification Description
08 05 13 00	01 22 16 00	No Specification Required

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SECTION 08 71 11 00 - DOOR HARDWARE

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of material for door hardware. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes the following:
 - a. Mechanical door hardware for the following:
 - 1) Swinging doors.
 - 2) Sliding doors.
 - 3) Folding doors.
 - b. Cylinders for doors specified in other Sections.
 - c. Electrified door hardware.
2. Products furnished, but not installed, under this Section include the products listed below. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
 - a. Pivots, thresholds, weather stripping, and cylinders for locks specified in other Sections.
 - b. Permanent cores to be installed by the Owner.

C. Action Submittals

1. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Shop Drawings: Details of electrified door hardware, indicating the following:
 - a. Wiring Diagrams: For power, signal, and control wiring and including the following:
 - 1) Details of interface of electrified door hardware and building safety and security systems.
 - 2) Schematic diagram of systems that interface with electrified door hardware.
 - 3) Point-to-point wiring.
 - 4) Risers.
 - 5) Elevations doors controlled by electrified door hardware.
 - b. Operation Narrative: Describe the operation of doors controlled by electrified door hardware.
3. Samples for Initial Selection: For plastic protective trim units in each finish, color, and texture required for each type of trim unit indicated.
4. Samples for Verification: For exposed door hardware of each type required, in each finish specified, prepared on Samples of size indicated below. Tag Samples with full description for coordination with the door hardware schedule. Submit Samples before, or concurrent with, submission of door hardware schedule.
 - a. Sample Size: Full-size units or minimum **2-by-4-inch (51-by-102-mm)** Samples for sheet and **4-inch (102-mm)** long Samples for other products.
 - 1) Full-size Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.
5. Other Action Submittals:
 - a. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

- 1) Submittal Sequence: Submit door hardware schedule after or concurrent with submissions of Product Data, Samples, and Shop Drawings, **as directed**. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
- 2) Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page.
- 3) Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
- 4) Content: Include the following information:
 - a) Identification number, location, hand, fire rating, size, and material of each door and frame.
 - b) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - c) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
 - d) Description of electrified door hardware sequences of operation and interfaces with other building control systems.
 - e) Fastenings and other pertinent information.
 - f) Explanation of abbreviations, symbols, and codes contained in schedule.
 - g) Mounting locations for door hardware.
 - h) List of related door devices specified in other Sections for each door and frame.
- b. Keying Schedule: Prepared by or under the supervision of Installer, detailing the Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

D. Informational Submittals

1. Qualification Data: For Installer and Architectural Hardware Consultant.
2. Product Certificates: For electrified door hardware, from the manufacturer.
 - a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
3. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.
4. Warranty: Special warranty specified in this Section.

E. Closeout Submittals

1. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.

F. Quality Assurance

1. Installer Qualifications: An employer of workers trained and approved by lock manufacturer.
 - a. Installer's responsibilities include supplying and installing door hardware and providing a qualified Architectural Hardware Consultant available during the course of the Work to consult with Contractor, Architect, and the Owner about door hardware and keying
2. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant **OR** one who meets the requirements necessary for certification, **as directed**, and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.
3. Source Limitations: Obtain each type of door hardware from a single manufacturer.
 - a. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that

- are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.
4. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and labeled by a qualified testing, for fire protection ratings indicated, based on testing at positive pressure according to NFPA 252 **OR** UL 10C, unless otherwise indicated.
 5. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meet requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
 - a. Air Leakage Rate: Maximum air leakage of **0.3 cfm/sq. ft. (3 cu. m per minute/sq. m)** at the tested pressure differential of **0.3-inch wg (75 Pa)** of water.
 6. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
 7. Means of Egress Doors: Latches do not require more than **15 lbf (67 N)** to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
 8. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines **OR** ICC/ANSI A117.1 **OR** HUD's "Fair Housing Accessibility Guidelines", **as directed**.
 - a. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than **5 lbf (22.2 N)**.
 - b. Comply with the following maximum opening-force requirements:
 - 1) Interior, Non-Fire-Rated Hinged Doors: **5 lbf (22.2 N)** applied perpendicular to door.
 - 2) Sliding or Folding Doors: **5 lbf (22.2 N)** applied parallel to door at latch.
 - 3) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 - c. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than **1/2 inch (13 mm)** high and **3/4 inch (19 mm)** high for exterior sliding doors.
 - d. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point **3 inches (75 mm)** from the latch, measured to the leading edge of the door.
 9. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management And Coordination". In addition to the Owner, Contractor, and Architect, conference participants shall also include Installer's Architectural Hardware Consultant and Owner's security consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
 - a. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 - b. Preliminary key system schematic diagram.
 - c. Requirements for key control system.
 - d. Requirements for access control.
 - e. Address for delivery of keys.
 10. Preinstallation Conference: conduct conference at Project site.
 - a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Inspect and discuss preparatory work performed by other trades.
 - c. Inspect and discuss electrical roughing in for electrified door hardware.
 - d. Review sequence of operation for each type of electrified door hardware.
 - e. Review required testing, inspecting, and certifying procedures.
- G. Delivery, Storage, And Handling
1. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
 2. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
 3. Deliver keys to manufacturer of key control system for subsequent delivery to the Owner.
 4. Deliver keys and permanent cores to the Owner by registered mail or overnight package service.

H. Coordination

1. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 03.
2. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
3. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
4. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.
5. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

I. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - a. Failures include, but are not limited to, the following:
 - 1) Structural failures including excessive deflection, cracking, or breakage.
 - 2) Faulty operation of doors and door hardware.
 - 3) Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - b. Warranty Period: Three years from date of Final Completion, except as follows:
 - 1) Electromagnetic or Delayed-Egress Locks: Five years from date of Final Completion.
 - 2) Exit Devices: Two years from date of Final Completion.
 - 3) Manual Closers: 10 years from date of Final Completion.
 - 4) Concealed Floor Closers: Five **OR** 10 **OR** 25 years from date of Final Completion, **as directed**.

J. Maintenance Service

1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
2. Maintenance Service: Beginning at Final Completion, provide six months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door and door hardware operation. Provide parts and supplies that are the same as those used in the manufacture and installation of original products.

1.2 PRODUCTS**A. Scheduled Door Hardware**

1. General: Provide door hardware for each door indicated in Part 1.3 "Door Hardware Sets" Article to comply with requirements in this Section.
 - a. Door Hardware Sets: Provide quantity, item, size, finish or color indicated.
 - b. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
2. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 1.3 "Door Hardware Sets" Article. Products are identified by descriptive titles corresponding to requirements specified in Part 1.2.

B. Hinges

1. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.
2. Antifriction-Bearing Hinges:
 - a. Mounting: Full-Mortise (Butt) **OR** Half mortise **OR** Full surface **OR** Half surface, **as directed**.
 - b. Bearing Material: Manufacturer's standard antifriction bearing **OR** Ball bearing, **as directed**.
 - c. Grade: Grade 1 (heavy weight) **OR** Grade 2 (standard weight), **as directed**.
 - d. Base and Pin Metal:
 - 1) Exterior Hinges: Stainless steel with stainless-steel pin **OR** Brass with stainless-steel pin body and brass protruding heads, **as directed**.
 - 2) Interior Hinges: Brass with stainless-steel pin body and brass protruding heads **OR** Steel with steel pin **OR** Stainless steel with stainless-steel pin, **as directed**.
 - 3) Hinges for Fire-Rated Assemblies: Steel with steel pin **OR** Stainless steel with stainless-steel pin, **as directed**.
 - e. Pins: Non-rising loose unless otherwise indicated **OR** Maximum security **OR** Nonremovable, **as directed**.
 - 1) Outswinging Exterior Doors: Maximum security **OR** Nonremovable, **as directed**.
 - 2) Outswinging Corridor Doors with Locks: Maximum security **OR** Nonremovable, **as directed**.
 - f. Tips: Flat button **OR** Hospital **OR** Oval **OR** Ball **OR** Steeple **OR** Urn **OR** Acorn, **as directed**.
 - g. Corners: Square **OR** 5/32-inch (4-mm) radius **OR** 1/4-inch (6-mm) radius **OR** 5/8-inch (16-mm) radius, **as directed**.
 - h. Options: Raised barrel **OR** Reverse safety stud **OR** Safety stud, **as directed**.
3. Electrified Antifriction-Bearing Hinges: Full-mortise mounting.
 - a. Bearing Material: Manufacturer's standard antifriction bearing **OR** Ball bearing, **as directed**.
 - b. Grade: Grade 1 (heavy weight) **OR** Grade 2 (standard weight), **as directed**.
 - c. Base and Pin Metal:
 - 1) Exterior Hinges: Stainless steel with stainless-steel pin **OR** Brass with stainless-steel pin body and brass protruding heads, **as directed**.
 - 2) Interior Hinges: Brass with stainless-steel pin body and brass protruding heads **OR** Steel with steel pin **OR** Stainless steel with stainless-steel pin, **as directed**.
 - 3) Hinges for Fire-Rated Assemblies: Steel with steel pin **OR** Stainless steel with stainless-steel pin, **as directed**.
 - d. Pins: Non-rising loose unless otherwise indicated **OR** Maximum security **OR** Nonremovable, **as directed**.
 - 1) Outswinging Exterior Doors: Maximum security **OR** Nonremovable, **as directed**.
 - 2) Outswinging Corridor Doors with Locks: Maximum security **OR** Nonremovable, **as directed**.
 - e. Tips: Flat button **OR** Hospital **OR** Oval **OR** Ball **OR** Steeple **OR** Urn **OR** Acorn, **as directed**.
 - f. Corners: Square **OR** 5/32-inch (4-mm) radius **OR** 1/4-inch (6-mm) radius **OR** 5/8-inch (16-mm) radius, **as directed**.
 - g. Options: Raised barrel **OR** Reverse safety stud **OR** Safety stud, **as directed**.
 - h. Electric Option: Concealed electric through wires **OR** Concealed electric through wires with monitor **OR** Concealed electric monitor **OR** Concealed air transfer **OR** Concealed switch **OR** Exposed electric switch **OR** Exposed electric contacts, **as directed**.
4. Plain-Bearing Hinges: Grade 3 (standard weight).
 - a. Mounting: Full mortise (butts) **OR** Half mortise **OR** Full surface **OR** Half surface, **as directed**.
 - b. Base and Pin Metal: Brass with stainless-steel pin body and brass protruding heads **OR** Steel with steel pin, **as directed**.

- c. Pins: Non-rising loose unless otherwise indicated **OR** Maximum security **OR** Nonremovable, **as directed**.
 - 1) Outswinging Corridor Doors with Locks: Maximum security **OR** Nonremovable, **as directed**.
 - d. Tips: Flat button **OR** Hospital **OR** Oval **OR** Ball **OR** Steeple **OR** Urn **OR** Acorn, **as directed**.
 - e. Corners: Square **OR** 5/32-inch (4-mm) radius **OR** 1/4-inch (6-mm) radius **OR** 5/8-inch (16-mm) radius, **as directed**.
 - f. Options: Raised barrel, **as directed**.
- 5. Electrified Plain-Bearing Hinges: Grade 3 (standard weight); full-mortise mounting.
 - a. Mounting: Full mortise (butts) **OR** Half mortise **OR** Full surface **OR** Half surface, **as directed**.
 - b. Pins: Non-rising loose unless otherwise indicated **OR** Maximum security **OR** Nonremovable, **as directed**.
 - 1) Outswinging Corridor Doors with Locks: Maximum security **OR** Nonremovable, **as directed**.
 - c. Tips: Flat button **OR** Hospital **OR** Oval **OR** Ball **OR** Steeple **OR** Urn **OR** Acorn, **as directed**.
 - d. Corners: Square **OR** 5/32-inch (4-mm) radius **OR** 1/4-inch (6-mm) radius **OR** 5/8-inch (16-mm) radius, **as directed**.
 - e. Options: Raised barrel, **as directed**.
 - f. Electric Option: Concealed electric through wires **OR** Concealed electric through wires with monitor **OR** Concealed electric monitor **OR** Concealed air transfer **OR** Concealed switch **OR** Exposed electric switch **OR** Exposed electric contacts, **as directed**.
- 6. Swing-Clear Hinges: Reversible.
 - a. Mounting: Full mortise (butts) **OR** Half mortise **OR** Full surface **OR** Half surface, **as directed**.
 - b. Bearing, and Grade: Antifriction bearing, Grade 1 (heavy weight) **OR** Antifriction bearing, Grade 2 (standard weight) **OR** Plain bearing, Grade 3 (standard weight), **as directed**.
 - c. Base Metal: Wrought brass or bronze **OR** Stainless steel **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.
 - d. Pins: Non-rising loose unless otherwise indicated **OR** Maximum security **OR** Nonremovable, **as directed**.
 - 1) Outswinging Exterior Doors: Maximum security **OR** Nonremovable, **as directed**.
 - 2) Outswinging Corridor Doors with Locks: Maximum security **OR** Nonremovable, **as directed**.
 - e. Tips: Flat button **OR** Hospital, **as directed**.
 - f. Corners: Square **OR** 5/32-inch (4-mm) radius **OR** 1/4-inch (6-mm) radius **OR** 5/8-inch (16-mm) radius, **as directed**.
 - g. Options: Raised barrel **OR** Reverse safety stud **OR** Safety stud, **as directed**.
- 7. Slip-in-Type Hinges: Full-mortise mounting.
 - a. Bearing and Grade: Antifriction, Grade 1 (heavy weight) **OR** Antifriction, Grade 2 (standard weight) **OR** Plain, Grade 3 (standard weight), **as directed**.
 - b. Base Metal: Wrought brass or bronze **OR** Stainless steel **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.
 - c. Swaging: 5/16-inch (7.9-mm) swaging **OR** 3/16-inch (4.8-mm) swaging, handed, **as directed**.
- 8. Anchor Hinge Set: Grade 1 (heavy weight); consisting of one anchor hinge plus two full-mortise hinges; antifriction bearing; handed; nonremovable pins; flat-button tips.
 - a. Base Metal: Wrought brass or bronze **OR** Stainless steel **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.
 - b. Electric Option for Center Hinge: Concealed electric through wires **OR** Concealed electric switch, **as directed**.

9. Pocket Hinges: Antifriction bearing; Grade 1 (heavy weight); jamb leaf visible when door is closed and both leaves concealed when door is in pocket; type required for application indicated; cast steel.
 10. Double-Acting Pivot-Hinge Set: Grade 2; wrought, forged, or cast steel or malleable iron base metal; consisting of a top pivot and a bottom pivot, each with jamb brackets, and bottom pivot with thrust steel bearing.
- C. Self-Closing Hinges And Pivots
1. Self-Closing Hinges and Pivots: BHMA A156.17.
 2. Spring Hinges: Grade 1 **OR** Grade 2, **as directed**; wrought steel, with torsion spring.
 - a. Type: Single **OR** Double, **as directed** acting.
 - b. Mounting: Full mortise (butts) **OR** Half mortise **OR** Full surface **OR** Half surface, **as directed**.
 3. Horizontal-Spring Pivot Sets: Grade 3; double acting; non-handed; consisting of wrought steel bottom pivot hinge with antifriction bearing and nylon top pivot and socket.
 - a. Type: Hold-open **OR** Non-hold open, **as directed**.
 - b. Tension: Adjustable **OR** Fixed, **as directed**.
 - c. Bottom Pivot Trim: Steel **OR** Brass, **as directed**.
 - d. Bottom Plate: For bottom hinge attachment to floor **OR** jamb, **as directed**.
 4. Gate-Spring Pivot Sets: Grade 1; double acting; non-handed; consisting of bottom pivot with door and jamb bracket and top pivot assembly with jamb bracket.
 - a. Mounting: Mortise **OR** Surface, **as directed**.
 - b. Tension: Adjustable **OR** Fixed, **as directed**.
 - c. Base Metal: Cast, forged, or extruded brass or bronze **OR** Malleable iron, **as directed**.
 5. Gravity Pivot Sets: Grade 3; double acting; surface mounting; non-handed; consisting of bottom pivot with door and jamb bracket and top pivot assembly with jamb bracket.
 - a. Tension: Adjustable **OR** Fixed, **as directed**.
 - b. Base Metal: Wrought brass or bronze **OR** Steel, **as directed**.
- D. Center-Hung And Offset Pivots
1. Center-Hung and Offset Pivots: BHMA A156.4.
 2. Center-Hung Pivot Sets: Grade 1.
 - a. Top Pivots: Walking-beam type with retractable pin and oil-impregnated bronze bearing; mortised into door and frame.
 - b. Bottom Pivots: Surface floor mounted, **OR** Recessed in floor in cement case, **OR** Mortised into jamb, **as directed** and mortised into door; with thrust ball **OR** needle bearings, **as directed**.
 - c. Base Metal: Brass **OR** Bronze **OR** Steel, **as directed**.
 3. Offset Pivot Sets: Grade 1 **OR** 2, **as directed**.
 - a. Offset: **3/4 inch (19 mm)** **OR** **1-1/2 inches (38 mm)**, **as directed**.
 - b. Top Pivot: Full-mortise **OR** Half-surface **OR** Full-surface mounting, **as directed**; walking-beam type with retractable pin and oil-impregnated bronze bearing.
 - 1) Knuckle: Standard **OR** Asylum type, **as directed**.
 - 2) Option: With screw holes designed to straddle lead in the center of lead-lined door.
 - c. Bottom Pivot: Surface floor mounted, **OR** Recessed in floor in cement case, **OR** Mortised into jamb, **as directed** and mortised into door; with thrust ball **OR** needle, **as directed** bearing.
 - d. Base Metal: Brass **OR** Bronze **OR** Stainless steel **OR** Steel, **as directed**.
 4. Offset Intermediate Pivots: Grade 1; for use with offset pivot sets; with oil-impregnated bronze bearings.
 - a. Mounting: Full mortise, **3/4 inch (19 mm)** offset **OR** Full mortise, **1-1/2 inches (38 mm)** offset **OR** Half mortise **OR** Half surface **OR** Full surface, **as directed**.
 - b. Knuckle: Standard **OR** Asylum type, **as directed**.
 - c. Option: With screw holes designed to straddle lead in the center of lead-lined door.
 - d. Electric Option: Concealed monitoring **OR** Concealed power transfer **OR** Concealed power transfer for use with electrical panic devices and locks, **as directed**.

- e. Base Metal: Brass **OR** Bronze **OR** Stainless steel **OR** Steel, **as directed**.
 5. Pocket Pivots: Grade 1; full-mortise mounting; non-handed; allows door to nest in pocket with door surface flush with corridor wall when open; maximum 90-degree swing.
 - a. Base Metal: Bronze **OR** Stainless steel **OR** Steel, **as directed**.
 - b. Electric Option: Concealed power transfer in one hinge per door.
- E. Continuous Hinges
 1. Continuous Hinges: BHMA A156.26; minimum **0.120-inch- (3.0-mm-)** thick, hinge leaves with minimum overall width of **4 inches (102 mm)**; fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.
 2. Pin-and-Barrel-Type Hinges:
 - a. Grade: Grade 1-150 **OR** 1-300 **OR** 1-600 **OR** 2-150 **OR** 2-300 **OR** 2-600 **OR** 3-150 **OR** 3-300, **as directed**.
 - b. Exterior Hinges: Stainless steel.
 - c. Interior Hinges: Stainless steel **OR** Steel **OR** Aluminum, **as directed**.
 - d. Hinges for Fire-Rated Assemblies: Stainless steel with steel fire pins to hold fire-rated doors in place if required by tested listing **OR** Steel, **as directed**.
 - e. Type: Concealed leaf **OR** Swing clear **OR** Full surface with removable continuous caps over fasteners **OR** Half mortise, concealed door leaf and with removable continuous cap over fasteners on jamb leaf **OR** Half surface, concealed jamb leaf and with removable continuous cap over fasteners on door leaf, **as directed**.
 - f. Electric Option: Electric monitoring switch **OR** Electric through wires and monitor **OR** Electric through wires **OR** Concealed power transfer **OR** Exposed power transfer contact switch, **as directed**.
 3. Continuous, Gear-Type Hinges: Extruded-aluminum, pinless, geared hinge leaves joined by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust bearings.
 - a. Grade: Grade 1-150 **OR** 1-300 **OR** 1-600 **OR** 2-150 **OR** 2-300 **OR** 2-600 **OR** 3-150 **OR** 3-300, **as directed**.
 - b. Hinges for Fire-Rated Assemblies: With steel fire pins to hold fire-rated doors in place if required by tested listing.
 - c. Mounting: Concealed leaf **OR** Swing clear **OR** Full surface, with removable continuous caps over fasteners **OR** Half surface, concealed jamb leaf and with removable continuous cap over fasteners on door leaf, **as directed**.
 - d. Electric Option: Electric monitor **OR** Electric through wires and monitor **OR** Electric through wires **OR** Electric power transfer **OR** Exposed switch **OR** Exposed contact **OR** Removable electric through wires, **as directed**.
- F. Mechanical Locks And Latches
 1. Lock Functions: As indicated in door hardware schedule.
 2. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 - a. Bored Locks: Minimum **1/2-inch (13-mm)** latchbolt throw.
 - b. Mortise Locks: Minimum **3/4-inch (19-mm)** latchbolt throw.
 - c. Deadbolts: Minimum **1-inch (25-mm) OR 1.25-inch (32-mm)** bolt throw, **as directed**.
 3. Lock Backset: **2-3/4 inches (70 mm)**, unless otherwise indicated.
 4. Lock Trim:
 - a. Description: As indicated on Drawings, **as directed**.
 - b. Levers: Wrought **OR** Forged **OR** Cast, **as directed**.
 - c. Knobs: Wrought **OR** Forged **OR** Cast, **as directed**.
 - d. Escutcheons (Roses): Wrought **OR** Forged **OR** Cast, **as directed**.
 - e. Dummy Trim: Match knob **OR** lever, lock trim and escutcheons.
 - f. Operating Device: Lever **OR** Knob, **as directed** with escutcheons (roses).
 5. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

- a. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
- b. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
- c. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
- d. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.
- 6. Bored Locks: BHMA A156.2; Grade 1 **OR** 2, **as directed**; Series 4000.
- 7. Mortise Locks: BHMA A156.13; Operational **OR** Security, **as directed** Grade 1 **OR** 2, **as directed**; stamped steel case with steel or brass parts; Series 1000.
- 8. Interconnected Locks: BHMA A156.12; Grade 1 **OR** 2, **as directed**; Series 5000.
- 9. Roller Latches: BHMA A156.16; Grade 1; rolling plunger that engages socket or catch, with adjustable roller projection.
 - a. Material: Brass **OR** Bronze, **as directed**.
 - b. Mounting: Surface **OR** Mortise, **as directed**.
- 10. Push-Pull Latches: Bored, BHMA A156.2; Series 4000 **OR** Mortise, BHMA A156.13, **as directed**; Grade 1 **OR** 2, **as directed**; with paddle handles that retract latchbolt; capable of being mounted vertically or horizontally.
 - a. Lever and Escutcheon Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum, **as directed**.
 - b. Lettering: Engrave with the words "Pull" and "Push."
 - c. Lead Lining: 0.047 inch (1.2 mm) thick for escutcheon plate.

G. Auxiliary Locks

- 1. Bored Auxiliary Locks: BHMA A156.5; Grade 1 **OR** 2, **as directed**; with strike that suits frame.
 - a. Backset: 2-3/8 inches (60 mm) **OR** 2-3/4 inches (70 mm), **as directed**.
 - b. Material: Aluminum **OR** Brass **OR** Bronze **OR** Stainless steel **OR** Zinc alloy, **as directed**.
 - c. Deadlatches: Deadlocking latchbolt operated by key either side **OR** key outside and turn inside **OR** turn inside with no cylinder, **as directed**.
 - d. Deadlocks: Deadbolt operated by key either side **OR** key outside and turn inside **OR** turn inside with no cylinder **OR** key outside, no trim inside, **as directed**.
- 2. Mortise Auxiliary Locks: BHMA A156.5; Grade 1 **OR** 2, **as directed**; with strike that suits frame.
 - a. Backset: 2-3/4 inches (70 mm).
 - b. Material: Aluminum **OR** Brass **OR** Bronze **OR** Stainless steel **OR** Zinc alloy, **as directed**.
 - c. Deadlocks: Deadbolt operated by key either side **OR** outside and turn inside **OR** one side, **as directed**.
 - d. Deadlatches: Latchbolt and auxiliary deadlatch operated by key either side **OR** outside and turn inside, **as directed**.
 - e. Deadlocks for Sliding Doors: Expanding- or interlocking-type deadbolt operated by key either side **OR** outside and turn inside **OR** one side, **as directed**.
 - f. Deadlatches for Sliding Doors: Hook-type latchbolt operated by key either side **OR** outside and handle inside, **as directed**.
- 3. Narrow Stile Auxiliary Locks: BHMA A156.5; Grade 1 **OR** 2, **as directed**; with strike that suits frame.
 - a. Backset: 0.98 inch (25 mm) **OR** 1.125 inches (29 mm) **OR** 1.25 inches (32 mm) **OR** 1.5 inches (38 mm) **OR** 1.75 inches (44 mm) **OR** 2 inches (51 mm) **OR** 2.25 inches (57 mm) **OR** 2.5 inches (64 mm), **as directed**.
 - b. Strike: Flat **OR** Flat with extra-long lip **OR** Radius **OR** Radius with weatherstrip **OR** Bevel, **as directed**.
 - c. Case Material: Steel **OR** Stainless steel, **as directed**.
 - d. Armored Front and Strike Material: Aluminum **OR** Brass **OR** Bronze **OR** Stainless steel, **as directed**.
 - e. Deadlock: Deadlocking bolt.
 - 1) Operation: Key both sides **OR** outside and operating trim inside, **as directed**.
 - 2) Door Application: Swinging **OR** Sliding door, **as directed**.
 - f. Deadlatch: Latchbolt with auxiliary deadlatch operated by key outside and paddle or lever inside; for single swinging doors.

- g. Multipoint Lock: Deadlocking bolt for pairs of swinging doors.
 - 1) Operation: Key both sides **OR** outside and turn, lever, or knob inside, **as directed**.
 - 2) Type: Two **OR** Three point, **as directed**.
- h. Latch/Lock: Deadbolt and latchbolt; both operated by key both sides; inside handle operates only latchbolt.
- 4. Push-Button Combination Locks: BHMA A156.5; cylindrical; Grade 1 **OR** mortise; Grade 2, **as directed**; lock opens by entering a one- to five-digit code by pushing correct buttons in correct sequence; automatically relocks when door is closed; with strike that suits frame.
 - a. Lockset Configuration: Standard **OR** Privacy with inside push button, **as directed**.
 - b. Auxiliary Lock Configuration: Deadbolt **OR** Deadlocking latch **OR** Deadlocking rim latch, **as directed**.
 - c. Override: By key cylinder.
- H. Electric Strikes
 - 1. Electric Strikes: BHMA A156.31; Grade 1 **OR** 2, **as directed**; with faceplate to suit lock and frame.
 - a. Material: Steel **OR** Stainless steel **OR** Zinc-aluminum alloy, **as directed**.
 - b. Mounting: Mortised **OR** Semirim mounted **OR** Rim mounted, **as directed**.
 - 2. Fire-Rated Door Assemblies: Use fail-secure electric strikes with fire-rated devices.
 - 3. Monitoring: Mechanical latchbolt **OR** Infrared latchbolt **OR** Mechanical strike **OR** Infrared strike, **as directed**.
 - 4. Options: Lip extension kit.
- I. Electromagnetic Locks
 - 1. Electromagnetic Locks: BHMA A156.23; electrically powered; with electromagnet attached to frame and armature plate attached to door; full-exterior or full-interior type, as required by application indicated.
 - a. Direct-Hold Type: Lock mounted on bottom of header; strike flush mounted on door push side **OR** face of header; strike angle mounted on door pull side **OR** side of jamb; strike flush mounted on door push side, **as directed**.
 - b. Shear Type: Lock mounted on face of header; strike angle mounted on door **OR** mortised in header; strike mortised in top of door **OR** mortised in jamb; strike mortised in edge of door **OR** mortised in bottom of door; strike mortised in floor **OR** mortised in floor; strike mortised in bottom of door, **as directed**.
 - c. Strength Ranking: **1500 lbf (6672 N) OR 1000 lbf (4448 N) OR 500 lbf (2224 N), as directed**.
 - d. Inductive Kickback Peak Voltage: Not more than 53 **OR** 0 V, **as directed**.
 - e. Residual Magnetism: Not more than **4 lbf (18 N) OR 0 lbf (0 N), as directed** to separate door from magnet.
 - f. Options:
 - 1) Magnetic bond sensor.
 - 2) Continuous housing for full width of door.
 - 3) Continuous housing for full height of door.
 - 4) Single LED indicators.
 - 5) Double LED indicators.
 - 6) Adjustable time delay with automatic relock.
 - 7) Integral door position switch.
 - 2. Delayed-Egress Electromagnetic Locks: BHMA A156.24, electrically powered, with electromagnet attached to frame and armature plate attached to door; depressing push bar for more than 3 seconds initiates irreversible alarm and 15-second delay for egress. When integrated with fire alarm, fire alarm voids 15-second delay.
 - a. Grade: Security Grade, activated from secure side of door by initiating device **OR** Movement Grade, activated by door movement as initiating device, **as directed**.
- J. Electromechanical Locks

1. Electromechanical Locks: BHMA A156.25; Grade 1 **OR** 2, **as directed**; motor or solenoid driven; bored **OR** mortise latchbolt **OR** mortise deadbolt **OR** mortise deadlocking latchbolt, **as directed**; with strike that suits frame.
- K. Self-Contained Electronic Locks
 1. Self-Contained Electronic Locks: BHMA A156.25, bored **OR** mortise, **as directed**; with internal, battery-powered, self-contained electronic locks; consisting of complete lockset, motor-driven lock mechanism, and actuating device; enclosed in zinc-dichromate-plated, wrought-steel case, and strike that suits frame. Provide key override, low-battery detection and warning, LED status indicators, and ability to program at the lock.
 - a. Actuating Device: Digital keypad **OR** Magnetic-stripe card reader, **as directed**.
 - 1) Card: Manufacturer's standard **OR** 0.030-inch- (0.76-mm-) thick PVC or polyester **OR** Custom, **as directed**.
 - 2) Accessory: Card encoder and software.
 - b. Faceplate Material: Wrought brass **OR** Wrought bronze **OR** Stainless steel, **as directed**.
 - c. Trim: Lever **OR** Knob **OR** Match trim specified for mechanical locks, **as directed**.
 - d. Function: Latch with **OR** Deadbolt with **OR** Latch without **OR** Deadbolt without, **as directed** key.
- L. Exit Locks And Exit Alarms
 1. Exit Locks and Alarms: BHMA A156.29, Grade 1.
 2. Exit Locks: Surface mounted; battery powered, housed in metal case; with manufacturer's standard strike that suits frame; with red-and-white lettering reading "EMERGENCY EXIT PUSH TO OPEN--ALARM WILL SOUND."
 - a. Single-Door **OR** Pairs-of-Door Type, **as directed**: Activated by arm, push plate, or paddle **OR** horizontal bar, **as directed**.
 - b. Options:
 - 1) Low-battery alert.
 - 2) Outside key control.
 - 3) Audible alarm that sounds when unauthorized use of door occurs.
 - 4) Silent alarm with remote signal capability for connection to remote indicating panel.
 - 5) Strike: Surface **OR** Mortise, **as directed**.
 3. Stand-Alone Exit Alarms: Surface mounted on door **OR** Mounted separate from door and activated by door movement switch, **as directed**.
 - a. Options:
 - 1) Low-battery alert.
 - 2) Outside key control.
 - 3) Audible alarm that sounds when unauthorized use of door occurs.
 - 4) Automatic rearming after authorized use, with adjustable time delay, **as directed**.
 - 5) Remote signal capability for connection to remote indicating panel.
- M. Surface Bolts
 1. Surface Bolts: BHMA A156.16.
 2. Half-Round Surface Bolts: Grade 1 **OR** 2, **as directed**, 6-inch (152-mm) polished-brass or burnished-steel, half-round rod and knob; minimum 7/8-inch (22-mm) throw; with universal strike.
 3. Interlocking Surface Bolts: Grade 1 **OR** 2, **as directed**, 6-inch (152-mm) extruded-brass or aluminum, interlocking track and rod; minimum 15/16-inch (24-mm) throw; with universal or mortise strike.
 4. Fire-Rated Surface Bolts: Grade 1 **OR** 2, **as directed**, 8-inch (203-mm) steel bolt with 2 steel guides; minimum 1-inch (25-mm) throw; listed and labeled for fire-rated doors; with universal strike.
 5. Dutch-Door Surface Bolts: Grade 1 **OR** 2, **as directed**, polished-brass bolt and knob, minimum 3/4-inch (19-mm) throw, with standard strike.
- N. Manual Flush Bolts

1. Manual Flush Bolts: BHMA A156.16; minimum **3/4-inch (19-mm)** throw; designed for mortising into door edge.
 2. Manual-Extension Flush Bolts: Grade 1 **OR 2, as directed**, fabricated from extruded brass or aluminum, with **12-inch (305-mm)** rod actuated by flat lever; listed and labeled for fire-rated doors, **as directed**. Provide with matching **OR** dustproof strike, **as directed**.
 3. Slide Flush Bolts: Grade 1 **OR 2, as directed**, cast brass, with rod actuated by slide. Provide with matching **OR** dustproof strike, **as directed**.
 4. Tubular Bolts: Grade 1 **OR 2, as directed**, polished-brass or polished-bronze, oval turn knob and escutcheon; minimum **9/16-inch (14-mm)** steel bolt with **1/2-inch (13-mm)** throw. Provide with matching **OR** dustproof strike, **as directed**.
 5. Dustproof Strikes: Locking type, Grade 1, polished wrought brass, with **3/4-inch- (19-mm-)** diameter, spring-tension plunger.
- O. Automatic And Self-Latching Flush Bolts
1. Automatic and Self-Latching Flush Bolts: BHMA A156.16; minimum **3/4-inch (19-mm)** throw; designed for mortising into door edge.
 2. Automatic Flush Bolts: Grade 1 **OR 2, as directed**, fabricated from steel and brass components, with spring-activated bolts that automatically retract when active leaf is opened and that automatically engage when active door depresses bolt trigger; listed and labeled for fire-rated doors, **as directed**. Provide brass or stainless-steel cover plate, top and bottom matching **OR** dustproof strikes, **as directed**, guides, guide supports, wear plates, and shims.
 3. Self-Latching Flush Bolts: Grade 1 **OR 2, as directed**, fabricated from steel and brass components, with spring-activated bolts that automatically engage when active door depresses trigger; listed and labeled for fire-rated doors, **as directed**. Bolts are manually retracted by a slide in the bolt face. Provide brass or stainless-steel cover plate, matching **OR** dustproof, **as directed** top and bottom strikes, guides, guide supports, wear plates, and shims.
 4. Dustproof Strikes: Locking type, Grade 1, polished wrought brass, with **3/4-inch- (19-mm-)** diameter, spring-tension plunger.
- P. Exit Devices And Auxiliary Items
1. Exit Devices and Auxiliary Items: BHMA A156.3.
 2. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.
 3. Fire Exit Devices: Devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.
 4. Rim Exit Devices: Grade 1 **OR 2, as directed**.
 - a. Type: Type 1, rim **OR** Type 4, narrow stile **OR** Type 28, incorporating a deadbolt, **as directed**.
 - b. Grade: Grade 1 **OR 2, as directed**.
 - c. Actuating Bar: Cross bar **OR** Push pad **OR** Narrow-stile push pad, **as directed**.
 - d. Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum **OR** Wrought steel, **as directed**.
 - e. Electrified Options:
 - 1) Pushpad monitor switch.
 - 2) Double-pushpad monitor switch.
 - 3) Electric locking and unlocking.
 - 4) Delayed egress.
 - 5) Alarm.
 5. Mortise Exit Devices: Grade 1 **OR 2, as directed**.
 - a. Type: Type 3 **OR** Type 10, narrow stile, **as directed**.
 - b. Grade: Grade 1 **OR 2, as directed**.
 - c. Actuating Bar: Cross bar **OR** Push pad **OR** Narrow-stile push pad, **as directed**.
 - d. Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum **OR** Wrought steel, **as directed**.

- e. Electrified Options:
 - 1) Pushpad monitor switch.
 - 2) Double-pushpad monitor switch.
 - 3) Electric locking and unlocking.
 - 4) Delayed egress.
 - 5) Alarm.
6. Surface Vertical-Rod Exit Devices: Grade 1 **OR 2, as directed.**
 - a. Type: Type 2 **OR** Type 5, narrow stile, **as directed.**
 - b. Grade: Grade 1 **OR 2, as directed.**
 - c. Actuating Bar: Cross bar **OR** Push pad **OR** Narrow-stile push pad, **as directed.**
 - d. Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum **OR** Wrought steel, **as directed.**
 - e. Configuration: Top and bottom rods **OR** Top rod, **as directed.**
 - f. Electrified Options:
 - 1) Pushpad monitor switch.
 - 2) Double-pushpad monitor switch.
 - 3) Electric locking and unlocking.
 - 4) Delayed egress.
 - 5) Alarm.
7. Concealed Vertical-Rod Exit Devices: Grade 1 **OR 2, as directed.**
 - a. Type: Type 6, narrow stile **OR** Type 7, for wood doors **OR** Type 8, for metal doors, **as directed.**
 - b. Grade: Grade 1 **OR 2, as directed.**
 - c. Actuating Bar: Cross bar **OR** Push pad **OR** Narrow-stile push pad, **as directed.**
 - d. Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum **OR** Wrought steel, **as directed.**
 - e. Electrified Options:
 - 1) Pushpad monitor switch.
 - 2) Double-pushpad monitor switch.
 - 3) Electric locking and unlocking.
 - 4) Delayed egress.
 - 5) Alarm.
8. Combination Exit Devices: Grade 1 **OR 2, as directed.**
 - a. Type: Type 9, rim and surface vertical rod **OR** Type 11, mortise and surface vertical rod **OR** Type 12, mortise and concealed vertical rod, **as directed.**
 - b. Grade: Grade 1 **OR 2, as directed.**
 - c. Actuating Bar: Cross bar **OR** Push pad **OR** Narrow-stile push pad, **as directed.**
 - d. Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum **OR** Wrought steel, **as directed.**
 - e. Electrified Options:
 - 1) Pushpad monitor switch.
 - 2) Double-pushpad monitor switch.
 - 3) Electric locking and unlocking.
 - 4) Delayed egress.
 - 5) Alarm.
9. Automatic Latching Two-Point Bolts: Grade 1.
 - a. Type: Type 23, concealed **OR** Type 24, surface, **as directed.**
 - b. Material: Brass **OR** Bronze **OR** Stainless steel, **as directed.**
10. Extension Flush Bolt Sets: BHMA A156.3; Grade 1.
 - a. Type: Type 25, automatic **OR** Type 27, self-latching, **as directed.**
 - b. Material: Brass **OR** Bronze **OR** Stainless steel, **as directed.**
11. Electronic Exit Bars: Nonlatching electronic actuating (releasing) device activated by an adjustable capacitance sensor and with no moving parts; listed and labeled as panic exit hardware. Fabricate bar from extruded aluminum, and provide door and frame transfer device and 16 feet (4.9 m) of cord to route wiring off the door frame.

12. Extruded-Aluminum Removable Mullions: With malleable-iron top and bottom retainers, and prepared for strikes as follows:
 - a. Strikes: Two standard recessed strikes **OR** Two monitor strikes **OR** One standard and one electric strike, **as directed**.
13. Tube-Steel Removable Mullions: With malleable-iron top and bottom retainers, and prepared for strikes as follows:
 - a. Strikes: Two standard recessed strikes **OR** Two monitor strikes **OR** One standard and one electric strike, **as directed**.
14. Fire-Exit Removable Mullions: Provide removable mullions for use with fire exit devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire and panic protection, based on testing according to UL 305 and NFPA 252. Use mullions only with exit devices for which they have been tested.
15. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
 - a. Operation: Rigid **OR** Movable **OR** Movable with monitor switch, **as directed**.
16. Exit Device Outside Trim: Lever **OR** Lever with cylinder **OR** Knob **OR** Knob with cylinder **OR** Pull **OR** Pull with cylinder **OR** Thumb turn with cylinder, **as directed**; material and finish to match locksets, unless otherwise indicated.
 - a. Match design for lock trim, unless otherwise indicated.
17. Through-Bolt Fasteners: For exit devices and trim on metal doors **OR** non-fire-rated wood doors **OR** fire-rated wood doors, **as directed**.

Q. Lock Cylinders

1. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.
2. Standard Lock Cylinders: BHMA A156.5; Grade 1 **OR** 1A **OR** 2, **as directed**; permanent cores that are interchangeable **OR** removable, **as directed**; face finished to match lockset.
 - a. Number of Pins: Five **OR** Six **OR** Seven, **as directed**.
 - b. Type: Mortise **OR** Rim **OR** Bored-lock, **as directed** type.
3. High-Security Lock Cylinders: BHMA A156.30; Grade 1 **OR** 2 **OR** 3, **as directed**; Type M, mechanical **OR** E, electrical, **as directed**; permanent cores that are removable; face finished to match lockset.
 - a. Number of Pins: Six **OR** Seven, **as directed**.
 - b. Type: Mortise **OR** Rim **OR** Bored-lock, **as directed** type.
4. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.
5. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

R. Keying

1. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference.
 - a. No Master Key System: Only change keys operate cylinder.
 - b. Master Key System: Change keys and a master key operate cylinders.
 - c. Grand Master Key System: Change keys, a master key, and a grand master key operate cylinders.
 - d. Great-Grand Master Key System: Change keys, a master key, a grand master key, and a great-grand master key operate cylinders.
 - e. Existing System:
 - 1) Master key or grand master key locks to Owner's existing system.
 - 2) Re-key Owner's existing master key system into new keying system.
 - f. Keyed Alike: Key all cylinders to same change key.
2. Keys: Nickel silver **OR** Brass, **as directed**.
 - a. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

- 1) Notation: "DO NOT DUPLICATE." **OR** Information to be furnished by Owner., **as directed**
 - b. Quantity: In addition to one extra key blank for each lock, provide the following:
 - 1) Cylinder Change Keys: Three.
 - 2) Master Keys: Five.
 - 3) Grand Master Keys: Five.
 - 4) Great-Grand Master Keys: Five.
- S. Key Control System
1. Key Control Cabinet: BHMA A156.5; metal cabinet with baked-enamel finish; containing key-holding hooks, labels, 2 sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers; with key capacity of 150 percent of the number of locks.
 - a. Multiple-Drawer Cabinet: Cabinet with drawers equipped with key-holding panels and key envelope storage, and progressive-type ball-bearing suspension slides. Include single cylinder lock to lock all drawers.
 - b. Wall-Mounted Cabinet: Cabinet with hinged-panel door equipped with key-holding panels and pin-tumbler cylinder door lock.
 - c. Portable Cabinet: Tray for mounting in file cabinet, equipped with key-holding panels, envelopes, and cross-index system.
 2. Key Lock Boxes: Designed for storage of two **OR** 10 keys, **as directed**, with tamper switches to connect to intrusion detection system, **as directed**.
 3. Cross-Index System: Multiple **OR** Single, **as directed**-index system for recording key information. Include three receipt forms for each key-holding hook. Set up by key control manufacturer **OR** Installer, **as directed**.
 4. Key Control System Software: BHMA A156.5, Grade 1; multiple-index system for recording and reporting key-holder listings, tracking keys and lock and key history, and printing receipts for transactions. Include instruction manual.
- T. Operating Trim
1. Operating Trim: BHMA A156.6; aluminum **OR** brass **OR** bronze **OR** stainless steel, **as directed**, unless otherwise indicated.
 2. Flat Push Plates: 0.050 inch (1.3 mm) **OR** 1/8 inch (3.2 mm) thick, **as directed**, 4 inches wide by 16 inches high (102 mm wide by 406 mm high), with square corners and beveled edges; secured with exposed screws.
 3. Push-Pull Plates: 1/8 inch (3.2 mm) thick, 3-1/2 inches wide by 15-3/4 inches high (89 mm wide by 400 mm high), with square corners, beveled edges, and raised integral lip; secured with exposed screws.
 4. Straight Door Pulls: With minimum clearance of 1-1/2 inches (38 mm) from face of door.
 - a. Type: 3/4-inch (19-mm) constant-diameter **OR** variable-diameter **OR** flattened-round **OR** hospital-type pull, **as directed**.
 - b. Mounting: Surface applied with concealed fasteners **OR** Through bolted with oval-head machine screws and countersunk washers **OR** Back to back with threaded sleeves, **as directed**.
 - c. Overall Length: 9 inches (229 mm), **as directed**.
 5. Offset Door Pulls: 1-inch (25-mm) constant-diameter pull with minimum clearance of 2-1/4 inches (57 mm) from face of door and offset of 2 inches (51 mm).
 - a. Mounting: Surface applied with concealed fasteners **OR** Through bolted with oval-head machine screws and countersunk washers **OR** Back to back with threaded sleeves, **as directed**.
 - b. Overall Length: 9 inches (229 mm).
 6. Flush Door Pulls: Mortised 1/2 inch (13 mm) deep; secured with screws.
 - a. Shape: Rectangular with rectangular recess.
 - b. Size: 3-1/2 inches wide by 4-3/4 inches high (89 mm wide by 121 mm high).
 7. Straight Pull-Plate Door Pulls: 0.050-inch- (1.3-mm-) thick plate, 4 inches wide by 16 inches high (102 mm wide by 406 mm high) with square corners and beveled edges; pull with minimum clearance of 1-1/2 inches (38 mm) from face of door.

- a. Type: **3/4-inch (19-mm)** constant-diameter **OR** variable-diameter **OR** flattened-round **OR** hospital-type pull, **as directed**.
- b. Mounting: Surface applied with concealed fasteners **OR** Through bolted with oval-head machine screws and countersunk washers **OR** Back to back with threaded sleeves, **as directed**.
- c. Overall Pull Length: **9 inches (229 mm)**.
8. Offset Push-Pull Door Pulls: **0.050-inch- (1.3-mm-)** thick plate, **4 inches wide by 16 inches high (102 mm wide by 406 mm high)** with square corners and beveled edges; **1-inch (25-mm)** constant-diameter pull with minimum clearance of **2-1/4 inches (57 mm)** from face of door and offset of **2 inches (51 mm)**.
 - a. Overall Pull Length: **9 inches (229 mm)**.
9. Single Push Bar: Horizontal bar, with minimum clearance of **1-1/2 inches (38 mm)** from face of door.
 - a. Shape and Size: **1-inch (25-mm)** constant-diameter round bar **OR** Minimum **3/8-by-1-1/4-inch (10-by-32-mm)** flat bar, **as directed**.
 - b. Mounting: Surface applied with concealed fasteners **OR** Through bolted with oval-head machine screws and countersunk washers, **as directed**.
10. Double Pull Bar: Two horizontal bars connected by matching vertical pull bar and spaced at **8 inches (200 mm)** o.c.; with minimum clearance of **1-1/2 inches (38 mm)** from face of door.
 - a. Shape and Size: **1-inch (25-mm)** constant-diameter round bars **OR** Minimum **3/8-by- 1-1/4-inch (10-by-32-mm)** flat bars, **as directed**.
 - b. Mounting: Surface applied with concealed fasteners **OR** Through bolted with oval-head machine screws and countersunk washers, **as directed**.

U. Accessories For Pairs Of Doors

1. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release; and with internal override.
2. Carry-Open Bars: BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.
3. Flat Overlapping Astragals: BHMA A156.22; flat primed steel **OR** zinc-plated steel **OR** aluminum **OR** stainless steel **OR** brass metal bar, **as directed**, surface mounted on face of door with screws; minimum **1/8 inch (3.2 mm)** thick by **2 inches (51 mm)** wide by full height of door.
4. Rigid, Housed Astragals: BHMA A156.22; gasket material held in place by metal housing; fastened to face of door with screws.
 - a. Gasket Material: Closed-cell sponge silicone **OR** Closed-cell sponge neoprene **OR** Neoprene **OR** Silicone bulb, **as directed**.
 - b. Housing Material: Aluminum **OR** Copper alloy (brass or bronze), **as directed**.
5. Overlapping-with-Gasket Astragals: BHMA A156.22; T-shaped metal, surface mounted on edge of door with screws; with integral gasket and base metal as follows:
 - a. Base Metal: Primed steel **OR** Zinc-plated steel **OR** Aluminum **OR** Stainless steel, **as directed**.
 - b. Gasket Material: Vinyl **OR** Silicone **OR** Sponge neoprene **OR** Brush pile **OR** Polypropylene, **as directed**.

V. Surface Closers

1. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
2. Cast-Aluminum Surface Closers: Grade 1 **OR** 2, **as directed**; Traditional Type with mechanism enclosed in cast-aluminum alloy shell.
 - a. Mounting: Hinge side **OR** Opposite hinge side **OR** Parallel arm **OR** Bracket, **as directed**.

- b. Type: Regular arm **OR** Fusible-link holder arm **OR** Two-point hold-open arm **OR** Delayed action closing, **as directed**.
 - c. Backcheck: Factory preset **OR** Adjustable, **as directed**, effective between 60 and 85 degrees of door opening.
- 3. Surface Closer without Cover: Grade 1 **OR** 2 Modern Type, **as directed**.
 - a. Mounting: Hinge side **OR** Opposite hinge side **OR** Parallel arm **OR** Bracket **OR** Hinge side top jamb **OR** Opposite side top jamb, **as directed**.
 - b. Type: Regular arm **OR** Hold open **OR** Fusible-link holder arm **OR** Slide track arm **OR** Dead stop **OR** Dead stop hold open **OR** Delayed action closing, **as directed**.
 - c. Backcheck: Factory preset **OR** Adjustable, **as directed**, effective between 60 and 85 degrees of door opening.
 - d. Closing Power Adjustment: At least 50 **OR** 35 **OR** 15 percent more than minimum tested value, **as directed**.
- 4. Surface Closer with Cover: Grade 1 **OR** 2 Modern Type, **as directed**; with mechanism enclosed in cover.
 - a. Mounting: Hinge side **OR** Opposite hinge side **OR** Parallel arm **OR** Bracket **OR** Hinge side, top jamb **OR** Opposite side, top jamb, **as directed**.
 - b. Type: Regular arm **OR** Hold open **OR** Fusible-link holder arm **OR** Slide track arm **OR** Dead stop **OR** Dead stop hold open **OR** Delayed action closing, **as directed**.
 - c. Backcheck: Factory preset **OR** Adjustable, **as directed**, effective between 60 and 85 degrees of door opening.
 - d. Cover Material: Aluminum **OR** Plated steel **OR** Molded plastic, **as directed**.
 - e. Closing Power Adjustment: At least 50 **OR** 35 **OR** 15 percent more than minimum tested value, **as directed**.

W. Concealed Closers

- 1. Concealed Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
- 2. Concealed-in-Door Closer: Grade 1 **OR** 2, **as directed**; mortised into top rail of minimum **1-3/4-inch- (44-mm-)** thick doors and track mortised into head frame; with double lever arm indicated.
 - a. Type: Surface shoe **OR** Mortised soffit plate, **as directed**.
 - b. Arm: Regular **OR** Hold open, **as directed**.
 - c. Closing Power Adjustment: At least 50 **OR** 35 **OR** 15 percent more than minimum tested value, **as directed**.
- 3. Concealed Overhead Closer: Grade 1 **OR** 2, **as directed**; mortised into head frame; with cast-metal body and exposed cover plate.
 - a. Type: Exposed arm with surface shoe, single acting **OR** Concealed arm and track, butt or pivot hung, single acting **OR** Concealed arm and track, center pivoted, single acting **OR** Concealed arm and track, center pivoted, double acting, **as directed**.
 - b. Arm: Regular **OR** Automatic hold open **OR** Manually selected hold open **OR** Fusible-link holder arm, **as directed**.
 - c. Track: Regular **OR** Automatic hold open **OR** Manually selected hold open, **as directed**.
 - d. Cover Plate Material: Aluminum **OR** Plated steel, **as directed**.
 - e. Backcheck: Factory preset **OR** Adjustable, **as directed**.
 - f. Closing Power Adjustment: At least 50 **OR** 35 percent more than minimum tested value, **as directed**.
- 4. Concealed Floor Closer: Grade 1 **OR** 2, **as directed**; with cement case and cast-iron closer body case and top pivot; for single **OR** double-acting doors, **as directed**.
 - a. Type: Center pivoted; include top pivot **OR** Offset pivoted; include top pivot **OR** Independently hung, **as directed**.
 - b. Fire Rated: Listed for use with labeled fire-rated doors where indicated.
 - c. Function: Regular **OR** Automatic hold open **OR** Manually selected hold open **OR** Delayed action closing, **as directed**.

- d. Backcheck: Factory preset **OR** Adjustable, **as directed**.
- e. Closing Power Adjustment: At least 50 **OR** 35 percent more than minimum tested value, **as directed**.
- f. Case Depth: Regular, **4 inches (100 mm)** **OR** Shallow, **2 inches (50 mm)**, **as directed**.
- g. Floor Plates: Provide flush cover plates matching door hardware finish **OR** recessed floor plates with insert of floor finish material and extended closer spindle to accommodate thickness of floor finish, **as directed** unless thresholds are indicated.
 - 1) Material: Aluminum **OR** Plated steel, **as directed**.

X. Closer Holder Release Devices

- 1. Closer Holder Release Devices: BHMA A156.15; Grade 1; closer connected with separate or integral releasing and fire- or smoke-detecting devices. Door shall become self-closing on interruption of signal to release device. Automatic release is activated by smoke detection system **OR** loss of power, **as directed**.
 - a. Type: Single-point hold open **OR** Multiple-point hold open **OR** Free-swinging release, **as directed**.
 - b. Mounting: Surface mounted on face of door **OR** Surface mounted on face of top jamb **OR** Surface mounted on stop **OR** Mortised into top rail of door **OR** Mortised into top jamb **OR** Recessed into floor, **as directed**.
 - c. Options: Adjustable backcheck **OR** Integral smoke detector **OR** Adjustable spring power **OR** Adjustable hold-open manual release force, **as directed**.

Y. Mechanical Stops And Holders

- 1. Wall- and Floor-Mounted Stops: BHMA A156.16; polished cast brass, bronze, or aluminum base metal, **as directed**.
- 2. Rigid-Type Floor Stop: Grade 1 **OR** 2, **as directed**; with rubber bumper; for surface-screw **OR** expansion-shield, **as directed** application.
- 3. Dome-Type Floor Stop: Grade 1 **OR** 2, **as directed**; with minimum **1-inch- (25-mm-)** high bumper for doors without threshold and **1-3/8-inch- (35-mm-)** high bumper for doors with threshold; provide with extruded aluminum riser for carpet installations.
- 4. Combination Floor Stop and Holder: Grade 1 **OR** 2, **as directed**; for surface-screw **OR** expansion-shield application, **as directed**; with semiautomatic hold open **OR** automatic hold open and release by pushing door, **as directed**.
- 5. Manual Combination Floor Stop and Holder: Grade 1 **OR** 2, **as directed**; **3-1/2 inches (89 mm)** long, with holder, keeper, and rubber bumper; for surface-screw **OR** expansion-shield application, **as directed**.
- 6. Chain Door Stops: Grade 2; welded chain, each end attached to compression springs, both covered with protective sleeve; for surface-screw application.
- 7. Wall Bumpers: Grade 1 **OR** 2, **as directed**; with rubber bumper; **2-1/2-inch (64-mm)** diameter, minimum **3/4-inch (19-mm)** projection from wall; with backplate for concealed fastener installation; with convex **OR** concave, **as directed** bumper configuration.
- 8. Roller-Type Wall Bumpers: Grade 1 **OR** 2, **as directed**; minimum **4-3/8-inch (111-mm)** projection from wall; for surface-screw application.
- 9. Lever-Type Door Holders: Grade 1 **OR** 2, **as directed**; minimum **4-inch- (102-mm-)** long arm that swings up and remains in vertical position; with replaceable rubber tip; for surface-screw application.
- 10. Plunger-Type Door Holders: Grade 1 **OR** 2, **as directed**; minimum **1-1/8-inch (29-mm)** plunger throw; with replaceable rubber tip; for surface-screw application.

Z. Electromagnetic Stops And Holders

- 1. Electromagnetic Door Holders: BHMA A156.15, Grade 1; wall-mounted electromagnetic single **OR** floor-mounted electromagnet single **OR** floor-mounted electromagnet double unit, **as directed** with strike plate attached to swinging door; coordinated with fire detectors and interface with fire alarm system for labeled fire-rated door assemblies.

AA. Overhead Stops And Holders

1. Overhead Stops and Holders: BHMA A156.8.
2. Overhead Concealed Slide Holders: Type 1; Grade 1 **OR 2, as directed**; hold open and release by push and pull of door unless control is set in inactive position; with stop, shock absorber, and adjustable holding pressure; for single **OR** double, **as directed**-acting doors opening 110 degrees.
3. Overhead Concealed Slide Stops: Type 1; Grade 1 **OR 2, as directed**; release by push and pull of door unless control is set in inactive position; with stop, shock absorber, and adjustable holding pressure; for single **OR** double, **as directed**-acting doors opening 110 degrees.
4. Overhead Surface-Mounted Slide Holders: Type 2; Grade 1 **OR 2, as directed**; hold open and release by push and pull of door unless control is set in inactive position; with stop, shock absorber, and adjustable holding pressure; for single-acting doors opening 110 degrees.
5. Overhead Surface-Mounted, Concealed Slide Stops: Type 2; Grade 1 **OR 2, as directed**; release by push and pull of door unless control is set in inactive position; with stop, shock absorber, and adjustable holding pressure; for single-acting doors opening 110 degrees.
6. Overhead Surface-Mounted, Jointed-Arm Holders: Type 3; Grade 1 **OR 2, as directed**; hold open and release by push and pull of door; control capable of being set in inactive position; with stop and shock absorber; for single-acting doors opening 110 degrees.
7. Overhead Surface-Mounted, Jointed-Arm Stops: Type 3; Grade 1 **OR 2, as directed**; release by push and pull of door; control capable of being set in inactive position; with stop and shock absorber; for single-acting doors opening 110 degrees.
8. Overhead Concealed, Friction Slide Holders: Type 4; Grade 1 **OR 2, as directed**; with frictional element held under adjustable pressure, free-acting shoulder pivots, and shock absorber; for single **OR** double, **as directed**-acting doors opening 110 degrees.
9. Overhead Concealed, Nonfriction Slide Stops: Type 4; Grade 1 **OR 2, as directed**; with nonfrictional element held under adjustable pressure and shock absorber; for single **OR** double, **as directed**-acting doors opening 110 degrees.
10. Overhead Concealed, Nonfriction Slide Holders: Type 4; Grade 1 **OR 2, as directed**; with nonfrictional element held under adjustable pressure, automatic hold-open, and shock absorber; for single **OR** double, **as directed**-acting doors opening 110 degrees.
11. Overhead Surface-Mounted, Friction Slide Holders: Type 5; Grade 1 **OR 2, as directed**; with frictional element held under adjustable pressure, free-acting shoulder pivots, and shock absorber; for single-acting doors opening 110 degrees.
12. Overhead Surface-Mounted, Nonfriction Slide Stops: Type 5; Grade 1 **OR 2, as directed**; with nonfrictional element held under adjustable pressure and shock absorber; for single-acting doors opening 110 degrees.
13. Overhead Surface-Mounted, Nonfriction Slide Holders: Type 5; Grade 1 **OR 2, as directed**; with nonfrictional element held under adjustable pressure, automatic hold-open, and shock absorber; for single-acting doors opening 110 degrees.
14. Overhead Surface-Mounted Rod Holders: Type 8; Grade 1 **OR 2, as directed**; hold open and release by push and pull of door unless roller cam is set in inactive position; with stop, shock absorber, and adjustable spring tension; for single-acting doors opening 110 degrees.
15. Overhead Surface-Mounted Rod Stops: Type 8; Grade 1 **OR 2, as directed**; release by push and pull of door unless roller cam is set in inactive position; with stop, shock absorber, and adjustable spring tension; for single-acting doors opening 110 degrees.
16. Overhead Surface-Mounted Cantilever Holders: Type 9; Grade 1 **OR 2, as directed**; hold open and release by push and pull of door or thumb turn; with stop and shock absorber; for single-acting doors opening 110 degrees.
17. Overhead Surface-Mounted Cantilever Stops: Type 9; Grade 1 **OR 2, as directed**; release by push and pull of door or thumb turn; with stop and shock absorber; for single-acting doors opening 110 degrees.

BB. Door Gasketing

1. Door Gasketing: BHMA A156.22; air leakage not to exceed **0.50 cfm per foot (0.000774 cu. m/s per m)** of crack length for gasketing other than for smoke control, as tested according to

- ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.
2. Adhesive-Backed Perimeter Gasketing: Vinyl bulb **OR** Sponge silicone **OR** Silicone **OR** Neoprene bulb **OR** Sponge neoprene gasket material, **as directed** applied to frame rabbet with self-adhesive.
 3. Spring-Metal Perimeter Gasketing: Minimum **0.008-inch- (0.20-mm-)** thick brass or bronze **OR** **0.008-inch- (0.20-mm-)** thick stainless steel **OR** **0.012-inch- (0.30-mm-)** thick aluminum gasket material, **as directed** fastened to frame rabbet with nails or screws.
 4. Rigid, Housed, Perimeter Gasketing: Sponge silicone **OR** Sponge neoprene **OR** Silicone bulb **OR** Polyurethane bulb **OR** Vinyl bulb **OR** Vinyl brush **OR** Nylon brush **OR** Thermoplastic elastomer, **as directed** gasket material held in place by aluminum **OR** brass or bronze **OR** stainless steel, **as directed** housing; fastened to frame stop with screws.
 5. Adjustable, Housed, Perimeter Gasketing: Screw-adjustable sponge silicone **OR** sponge neoprene **OR** silicone bulb **OR** polyurethane bulb **OR** vinyl bulb **OR** vinyl brush **OR** nylon brush **OR** thermoplastic elastomer gasket material, **as directed**, held in place by aluminum **OR** brass or bronze **OR** stainless steel housing, **as directed**; fastened to frame stop with screws.
 6. Interlocking Perimeter Gasketing: Minimum **0.018-inch- (0.46-mm-)** thick zinc **OR** **0.015-inch- (0.38-mm-)** thick bronze gasket material, **as directed** consisting of two pieces, one fastened to door and one fastened to frame, that interlock when door is closed; mounted with screws.
 7. Overlapping Astragals for Meeting Stiles: EPDM strip **OR** Vinyl strip **OR** Nylon brush gasket material, **as directed** held in place by aluminum **OR** bronze, **as directed** housing and overlapping when doors are closed; mounted to face of meeting stile with screws; surface mounted to each **OR** one door, **as directed**.
 8. Meeting Astragals for Meeting Stiles: Silicone bulb **OR** Neoprene bulb **OR** Vinyl bulb **OR** Nylon brush **OR** Brush pile **OR** Thermoplastic elastomer gasket material, **as directed** held in place by aluminum **OR** bronze housing, **as directed** mounted with screws.
 - a. Mounting: Surface mounted on face of each door **OR** Surface mounted on face of one door **OR** Semimortised into edge of each door **OR** Semimortised into edge of one door **OR** Mortised into edge of each door **OR** Mortised into edge of one door, **as directed**.
 9. Adjustable Astragals for Meeting Stiles: Screw-adjustable silicone **OR** neoprene **OR** vinyl **OR** vinyl-covered magnet **OR** brush pile **OR** thermoplastic elastomer gasket material, **as directed** held in place by aluminum **OR** bronze housing, **as directed** mounted with screws.
 - a. Mounting: Surface mounted on face **OR** Semimortised into edge **OR** Mortised into edge of each door, **as directed**.
 10. Door Sweeps: Neoprene **OR** Vinyl **OR** Nylon brush **OR** Polyurethane **OR** Silicone gasket material, **as directed** held in place by flat aluminum **OR** bronze, **as directed** housing or flange; surface mounted to face of door with screws.
 11. Door Shoes: Vinyl **OR** Thermoplastic elastomer **OR** Neoprene **OR** Brush pile gasket material, **as directed** held in place by aluminum **OR** bronze housing, **as directed**; mounted to bottom edge of door with screws.
 - a. Extended Housing: One side **OR** Both sides of door, **as directed**.
 - b. Mounting: Surface mounted on **OR** Mortised into bottom edge of door, **as directed**.
 12. Automatic Door Bottoms: Sponge neoprene **OR** Sponge silicone **OR** Thermoplastic elastomer **OR** Nylon brush gasket material, **as directed** held in place by aluminum **OR** bronze **OR** aluminum lined with **0.047-inch (1.2-mm)** thick lead housing, **as directed** that automatically drops to form seal when door is closed; mounted to bottom edge of door with screws.
 - a. Mounting: Surface mounted on face **OR** Semimortised into bottom **OR** Mortised into bottom of door, **as directed**.
 - b. Type: Low-closing-force type for doors required to meet accessibility requirements.

CC. Thresholds

1. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.
2. Compressing-Top Thresholds: Metal member with compressible vinyl seal on top of threshold that seals against bottom of door; and base metal of aluminum **OR** extruded bronze **OR** stainless steel, **as directed**.

3. Saddle Thresholds:
 - a. Type: Smooth top **OR** Fluted top **OR** Fluted top and offset **OR** Thermal break and fluted top **OR** Applied gasketed stop and fluted top **OR** Carpet separator with fluted top **OR** Fluted top, barrier free, **as directed**.
 - b. Base Metal: Aluminum **OR** Extruded bronze **OR** Stainless steel, **as directed**.
4. Half-Saddle Thresholds: Fluted-top metal member; and base metal of aluminum **OR** extruded bronze, **as directed**.
5. Interlocking Thresholds: Fluted-top metal member with integral lip designed to engage a hook strip applied to door.
 - a. Type: Single lip **OR** Double lip **OR** Double-lip water return **OR** Double-lip water return with aluminum pan **OR** Single lip with thermal barrier, **as directed**.
 - b. Base Metal: Aluminum **OR** Extruded bronze, **as directed**.
6. Latching/Rabbeted Thresholds:
 - a. Type: Fluted **OR** Smooth **OR** Offset with fluted top, **as directed**.
 - b. Base Metal: Aluminum **OR** Extruded bronze, **as directed**.
7. Latching/Rabbeted Thresholds with Gasket: Fluted-top metal member with gasket.
 - a. Type: Offset **OR** Thermal barrier, **as directed**.
 - b. Base Metal: Aluminum **OR** Extruded bronze, **as directed**.
 - c. Gasket Material: Vinyl **OR** Silicone **OR** Neoprene **OR** Brush pile **OR** Closed-cell sponge neoprene, **as directed**.
8. Latching/Rabbeted Panic Thresholds:
 - a. Type: Fluted, barrier free **OR** Fluted with gasket top, **as directed**.
 - b. Base Metal: Aluminum **OR** Extruded bronze, **as directed**.
9. Plate Thresholds: Solid metal plate.
 - a. Top Surface: Fluted **OR** Fluted with slip-resistant abrasive, **as directed**.
 - b. Base Metal: Aluminum **OR** Extruded brass or bronze **OR** Stainless steel, **as directed**.
10. Ramped Thresholds: Modular, interlocking, sloped, fluted-top metal assemblies with closed return ends; 1:12 slope.
 - a. Top Surface: Fluted **OR** Fluted with slip-resistant abrasive, **as directed**.
 - b. Base Metal: Aluminum **OR** Extruded bronze, **as directed**.
11. Saddle Thresholds for Floor Closers: Fluted top.
 - a. Type: Type A, for center-hung doors; ends not mitered **OR** Type B, for offset-hung doors; ends not mitered **OR** Type C, for center-hung doors; ends mitered **OR** Type D, for offset-hung doors; ends mitered, **as directed**.
 - b. Base Metal: Aluminum **OR** Extruded bronze, **as directed**.

DD. Sliding Door Hardware

1. Sliding Door Hardware: BHMA A156.14; consisting of complete sets including rails, hangers, supports, bumpers, floor guides, and accessories indicated.
2. Horizontal Sliding Door Hardware: Grade 1; rated for minimum door weight of **240 lb (109 kg) OR 320 lb (145 kg) OR 450 lb (205 kg) OR 560 lb (254 kg) OR 640 lb (290 kg) OR 800 lb (363 kg) OR 1000 lb (455 kg) OR 1500 lb (681 kg)**, **as directed**.
 - a. Material: Wrought steel **OR** Galvanized steel or anodized aluminum, **as directed**.
 - b. Rail: Box without mounting brackets **OR** Box with attached mounting brackets **OR** Box with attached flashing **OR** Round without mounting brackets **OR** Round with attached mounting brackets, **as directed**.
 - c. Rail Supports: Single sidewall **OR** Double sidewall **OR** Triple sidewall **OR** Single overhead **OR** Single overhead parallel **OR** Single overhead cross-ear **OR** Double overhead cross-ear **OR** Triple overhead cross-ear style, **as directed**.
 - 1) Provide intermediate, end, and splice type track supports as required by rail configuration and door weight indicated.
 - d. Hanger Configuration: Four-wheel truck **OR** hanger assembly with top mounting plate **OR** hanger assembly with drop bolt **OR** hanger assembly with single drop strap **OR** hanger assembly with double drop strap, **as directed**.
 - 1) Wheel Assembly: Steel wheels with ball bearings.
 - e. Accessories:

- 1) Continuous bottom guide.
 - 2) Guide rail and guide rail brackets as required by rail configuration.
 - 3) Bow handle, minimum **6 inches (150 mm)** in overall length.
 - 4) Flush pull, minimum **4 by 5-1/2 by 3/4 inch (100 by 140 by 19 mm)**, mortised into door.
 - 5) Cane bolt, minimum **1/2-inch (13-mm)** diameter by **12 inches (305 mm)** long.
 - 6) Stay roller, minimum **2-inch- (50-mm-)** diameter wheel.
 - 7) Floor center stop of cast iron.
 - 8) End guide and stop.
 - 9) Parallel door floor guides.
 - 10) Door stop.
 - 11) Sliding door latch.
 - 12) Bumper shoe, minimum **0.0598-inch (1.5-mm)** thickness.
 - 13) Cremona bolt with lever handle, minimum **1/2-inch- (13-mm-)** diameter oval or round rod, and rod guides at **24 inches (610 mm)** o.c.
 - 14) Top spring bolt, minimum **6 inches (150 mm) OR 8 inches (200 mm), as directed**; malleable iron and with angle or surface strike and **24-inch (610-mm)** chain.
 - 15) Foot bolt minimum **6 inches (150 mm) OR 8 inches (200 mm), as directed**; wrought steel, cast iron, or malleable iron.
3. Bypassing Sliding Door Hardware: Rails and door hardware that allow vertical adjustment and rated for doors weighing up to **120 lb (54 kg)** (Grade 1) **OR 80 lb (36 kg)** (Grade 1) **OR 40 lb (18 kg)** (Grade 2), **as directed**.
- a. Rail Material: Galvanized wrought steel **OR** Extruded aluminum, **as directed**.
 - b. Rail Configuration: V-grooved double leg **OR** V-grooved double leg with fascia **OR** I-beam, **as directed**.
 - c. Mounting: Top hung **OR** Bottom supporting with overhead guide, **as directed**.
 - d. Wheel Assembly: Two wheel or four wheel, with roller bearings.
 - e. Pulls: Flush, mortised into door **OR** Cast, forged, or extruded brass or bronze surface-applied type **OR** Wrought brass or bronze edge type, mortised into edge of door **OR** Sliding door latch **OR** Sliding door lock with emergency release, **as directed**.
 - f. Accessories:
 - 1) Bumper stops; wrought steel.
 - 2) Floor guides.
4. Pocket Sliding Door Hardware: Grade 1; rated for doors weighing up to **120 lb (54 kg) OR 80 lb (36 kg), as directed**, overhead box rails and door hardware that allows vertical adjustment.
- a. Rail Material: Galvanized wrought steel **OR** Extruded aluminum, **as directed**.
 - b. Door Type: Single **OR** Biparting, **as directed**.
 - c. Rail Configuration: V-grooved double leg **OR** I-beam, **as directed**.
 - d. Wheel Assembly: Two wheel or four wheel, roller bearings.
 - e. Pulls: Flush, mortised into door **OR** Cast, forged, or extruded brass or bronze surface-applied type **OR** Wrought brass or bronze edge type, mortised into edge of door **OR** Sliding door latch **OR** Sliding door lock with emergency release, **as directed**.
 - f. Accessories:
 - 1) Bumper stops; wrought steel.
 - 2) Floor guides installed within pocket.

EE. Folding Door Hardware

1. General: BHMA A156.14; complete sets including overhead rails, hangers, supports, bumpers, floor guides, and accessories indicated.
2. Bifolding Door Hardware: Rated for door panels weighing up to **50 lb (23 kg)** (Grade 1) **OR 30 lb (14 kg)** (Grade 2), **as directed**; with rails and door hardware that allow horizontal and vertical adjustment.
 - a. Rail Material: Galvanized wrought steel **OR** Extruded aluminum, **as directed**.
 - b. Rail Configuration: V-grooved double leg **OR** V-grooved double leg with fascia **OR** I-beam, **as directed**.

- c. Mounting: Surface mounted overhead **OR** Top and bottom hung, **as directed**.
- d. Wheel Assembly: Two wheel or four wheel, with roller bearings.
- 3. Multiple Folding Door Hardware: Rated for door panels weighing up to **50 lb (23 kg)** (Grade 1) **OR 30 lb (14 kg)** (Grade 2), **as directed**; with rails and door hardware that allows horizontal and vertical adjustment.
 - a. Rail Material: Galvanized wrought steel **OR** Extruded aluminum, **as directed**.
 - b. Rail Configuration: V-grooved double leg **OR** V-grooved double leg with fascia **OR** I-beam, **as directed**.
 - c. Mounting: Surface mounted overhead **OR** Top and bottom hung, **as directed**.
 - d. Wheel Assembly: Two wheel or four wheel, with roller bearing.

FF. Metal Protective Trim Units

- 1. Metal Protective Trim Units: BHMA A156.6; fabricated from **0.050-inch- (1.3-mm-)** thick aluminum **OR** brass **OR** bronze **OR** stainless steel, **as directed**; with manufacturer's standard machine or self-tapping screw fasteners.
- 2. Armor Plates: **36 inches (914 mm)** **OR 40 inches (1016 mm)** **OR 42 inches (1067 mm)** high, **as directed by** door width with allowance for frame stops.
- 3. Kick Plates: **8 inches (203 mm)** **OR 10 inches (254 mm)** **OR 12 inches (305 mm)** high, **as directed by** door width with allowance for frame stops.
- 4. Mop Plates: **4 inches (102 mm)** **OR 6 inches (152 mm)** high, **as directed by 1 inch (25 mm)** less than door width.
- 5. Stretcher Plates: **6 inches (152 mm)** **OR 8 inches (203 mm)** high, **as directed by** door width with allowance for frame stops.
- 6. Nonmortise Angle Door Edging: **48-inch- (1220-mm-)** **OR 42-inch- (1067-mm-)** high, **as directed by** minimum **0.050-inch- (1.3-mm-)** thick metal sheet formed into angle shape; with **1-1/4-inch (32-mm)** length of leg on face of door; for surface mounting on door.
 - a. Leg Offset: To accommodate door protection plate of type indicated.
- 7. Mortise Angle Door Edging: **48-inch- (1220-mm)** **OR 42-inch- (1067-mm-)** high, **as directed by** minimum **0.050-inch- (1.3-mm-)** thick metal sheet formed into angle shape; with **7/8-inch (22-mm)** length of leg on face of door; for mortise application into edge of door.
- 8. Nonmortise Cap Door Edging: **48-inch- (1220-mm)** **OR 42-inch- (1067-mm-)** high, **as directed by** minimum **0.050-inch- (1.3-mm-)** thick metal sheet formed into "U" shape; with **1-1/4-inch (32-mm)** length of leg on faces of door; for surface mounting on door.
 - a. Leg Offset: To accommodate door protection plate of type indicated.
- 9. Mortise Cap Door Edging: **48-inch- (1220-mm)** **OR 42-inch- (1067-mm-)** high, **as directed by** minimum **0.050-inch- (1.3-mm-)** thick metal sheet formed into "U" shape; with **7/8-inch (22-mm)** length of leg on faces of door; for mortise application into edge of door.

GG. Plastic Protection Plates

- 1. Plastic Protection Plates: BHMA A156.6; fabricated with four sides beveled; plastic laminate; **1/8 inch (3.2 mm)** thick; NEMA LD 3, Grade HGS **OR** rigid plastic; **0.060-inch- (1.5-mm-)** thick, PVC or acrylic-modified vinyl plastic **OR** acrylic; **1/8 inch (3.2 mm)** thick, **as directed**.
- 2. Armor Plates: **36 inches (914 mm)** **OR 40 inches (1016 mm)** **OR 42 inches (1067 mm)**, high, **as directed by** door width with allowance for frame stops.
- 3. Kick Plates: **8 inches (203 mm)** **OR 10 inches (254 mm)** **OR 12 inches (305 mm)** high **as directed by** door width with allowance for frame stops.
- 4. Mop Plates: **4 inches (102 mm)** **OR 6 inches (152 mm)** high **as directed by 1 inch (25 mm)** less than door width.
- 5. Stretcher Plates: **6 inches (152 mm)** **OR 8 inches (203 mm)** high **as directed by** door width with allowance for frame stops.
- 6. Colors and Textures: As selected by Architect from manufacturer's full range **OR** Match Architect's sample **OR** As indicated by manufacturer's designations in the door hardware schedule, **as directed**.

HH. Auxiliary Door Hardware

- 1. Auxiliary Hardware: BHMA A156.16.

2. Chain Door Guards: Grade 1 **OR 2 OR 3, as directed**; polished cast brass or bronze or extruded brass; with plate slotted to receive **6-inch- (150-mm-)** long welded chain secured to an anchor plate. Guard allows door to be opened **3 inches (75 mm)** with chain engaged in slotted plate. Equip with chain holder.
3. Rod-Type Door Guards: Grade 1 **OR 2 OR 3, as directed**; straight door-mounted rod that engages U-shaped, jamb-mounted rod. U-shaped rod can swing 180 degrees away from door; rod limits door opening when engaged. Fabricated from polished cast brass **OR** bronze **OR** aluminum, **as directed**.
4. Coat Hooks: Grade 1 **OR 2 OR 3, as directed**; two curved hooks with rounded ends; **3-inch (75-mm)** projection from wall; for surface-screw application; fabricated from polished cast brass **OR** polished cast bronze **OR** burnished cast aluminum, **as directed**.
5. Garment Hooks: Grade 1 **OR 2 OR 3, as directed**; one long hat hook and one small coat hook; **3-3/4-inch (95-mm)** projection from wall with **7-inch (178-mm)** overall height; for surface-screw application; fabricated from polished cast brass **OR** burnished cast aluminum, **as directed**.
6. Door Knockers: Grade 1; solid brass with engraved number and nameplates, **as directed**.
7. Wide-Angle Door Viewers: Grade 1 **OR 2 OR 3, as directed**; solid brass with optical glass lenses; adjustable to door thickness and permitting 1-way observation with minimum 190-degree viewing angle.
8. Fire-Rated Door Viewers: Solid brass with optical glass lenses; listed and labeled for use in fire-rated door assemblies; adjustable to door thickness, and permitting 1-way observation with minimum 120 **OR** 150 **OR** 190-degree viewing angle **as directed**.
9. House Numbers: Grade 1; wrought, cast, or forged brass; **4 inches (102 mm)** high; for screw application.
10. Letter Box Plates: Grade 1 **OR 2 OR 3, as directed**; with spring-loaded front plate with brass spring and inside covered gravity flap or hood; fabricated from wrought brass **OR** wrought bronze **OR** aluminum, **as directed**.
 - a. Regular Size, Inswinging: Minimum **0.036-inch (0.9-mm)** metal thickness, with minimum **7-by-1-5/8-inch (178-by-41-mm)** opening.
 - b. Regular Size, Outswinging: Minimum **0.036-inch (0.9-mm)** metal thickness, with minimum **7-by-1-1/2-inch (178-by-38-mm)** opening.
 - c. Magazine Size, Outswinging: Minimum **0.051-inch (1.3-mm)** metal thickness, with minimum **11-by-1-7/8-inch (279-by-48-mm)** opening.
11. Silencers for Wood Door Frames: Grade 1; neoprene or rubber; minimum **5/8 by 3/4 inch (16 by 19 mm)**; fabricated for drilled-in application to frame.
12. Silencers for Metal Door Frames: Grade 1; neoprene or rubber; minimum diameter **1/2 inch (13 mm)**; fabricated for drilled-in application to frame.

II. Auxiliary Electrified Door Hardware

1. Boxed Power Supplies: Modular unit in NEMA ICS 6, Type 4 enclosure; filtered and regulated; voltage rating and type matching requirements of door hardware served; listed and labeled for use with fire alarm systems.
2. Monitor Strikes: Cast strike with toggle **OR** Dustbox monitor for installation under standard strike, **as directed**.
3. Door Position Switches: Magnetically operated reed switch designed for concealed mounting.
4. Door and Frame Transfer Devices: Steel housing for mortise in hinge stile of door, with flexible tube for wiring bundle; accommodating doors that swing open to 120 degrees.

JJ. FABRICATION

1. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by the Owner.
 - a. Manufacturer's identification is permitted on rim of lock cylinders only.
2. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness.

- Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.
3. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
 - a. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 4. Fire-Rated Applications:
 - a. Wood or Machine Screws: For the following:
 - 1) Hinges mortised to doors or frames; use threaded-to-the-head wood screws for wood doors and frames, as directed.
 - 2) Strike plates to frames.
 - 3) Closers to doors and frames.
 - b. Steel Through Bolts: For the following unless door blocking is provided:
 - 1) Surface hinges to doors.
 - 2) Closers to doors and frames.
 - 3) Surface-mounted exit devices.
 5. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
 6. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors."
 7. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

KK. FINISHES

1. Provide finishes complying with BHMA A156.18.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.3 EXECUTION

A. Examination

1. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.
2. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation

1. Steel Doors and Frames: For Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI/SDI A250.6.
2. Wood Doors: Comply with DHI WDHS.5 "Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors."

C. Installation

1. Mounting Heights: Mount door hardware units at heights indicated on Drawings **OR** as follows, **as directed**, unless otherwise indicated or required to comply with governing regulations.
 - a. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 - b. Custom Steel Doors and Frames: HMMA 831.
 - c. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
2. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - a. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - b. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
3. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every **30 inches (750 mm)** of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
4. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every **30 inches (750 mm)** of door height greater than **90 inches (2286 mm)**.
5. Lock Cylinders: Install construction cores to secure building and areas during construction period.
 - a. Replace construction cores with permanent cores as directed by the Owner.
 - b. Furnish permanent cores to the Owner for installation.
6. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
7. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings **OR** in equipment room, **as directed**. Verify location with the Owner.
 - a. Configuration: Provide one power supply for each door opening **OR** least number of power supplies required to adequately serve doors, **as directed**.
8. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants".
9. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.
10. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
11. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
12. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

D. Field Quality Control

1. Independent Architectural Hardware Consultant: Engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
 - a. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

E. Adjusting

1. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 - a. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.

- b. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
 - c. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
 - 2. Occupancy Adjustment: Approximately three **OR** six months, **as directed**, after date of Final Completion, Installer's Architectural Hardware Consultant shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.
- F. Cleaning And Protection
- 1. Clean adjacent surfaces soiled by door hardware installation.
 - 2. Clean operating items as necessary to restore proper function and finish.
 - 3. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Final Completion.
- G. Demonstration
- 1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section "Demonstration And Training".

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SECTION 09 01 30 91 - CERAMIC TILE

1.1 GENERAL

A. Description Of Work

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

B. Summary

1. Section Includes:
 - a. Ceramic tile.
 - b. Porcelain tile.
 - c. Stone thresholds.
 - d. Waterproof membrane.
 - e. Crack isolation membrane.
 - f. Tile backing panels.
 - g. Metal edge strips.

C. Definitions

1. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
2. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in "American National Standard Specifications for Installation of Ceramic Tile."
3. Module Size: Actual tile size plus joint width indicated.
4. Face Size: Actual tile size, excluding spacer lugs.

D. Performance Requirements

1. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:
 - a. Level Surfaces: Minimum 0.6.
 - b. Step Treads: Minimum 0.6.
 - c. Ramp Surfaces: Minimum 0.8.

E. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittal:
 - a. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
4. Samples:
 - a. Full-size units of each type and composition of tile and for each color and finish required. For ceramic mosaic tile in color blend patterns, provide full sheets of each color blend.

OR

Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least **12 inches**

(300 mm) square, but not fewer than 4 tiles. Use grout of type and in color or colors approved for completed Work.

- b. Full-size units of each type of trim and accessory for each color and finish required.
- c. Stone thresholds in 6-inch (150-mm) lengths.
- d. Metal edge strips in 6-inch (150-mm) lengths.
- 5. Qualification Data: For qualified Installer.
- 6. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- 7. Product Certificates: For each type of product, signed by product manufacturer. Certification: Porcelain tile certified by the Porcelain Tile Certification Agency.
- 8. Material Test Reports: For each tile-setting and -grouting product, special purpose tile and certified porcelain tile.

F. Quality Assurance

- 1. Source Limitations for Tile: Obtain tile of each type and color or finish **OR** tile of each type **OR** tile of each color or finish **OR** tile, **as directed**, from one source or producer.
 - a. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- 2. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer.
- 3. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:
 - a. Stone thresholds.
 - b. Waterproof membrane.
 - c. Crack isolation membrane.
 - d. Joint sealants.
 - e. Cementitious backer units.
 - f. Metal edge strips.
- 4. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling

- 1. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- 2. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- 3. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- 4. Store liquid materials in unopened containers and protected from freezing.
- 5. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

H. Project Conditions

- 1. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

1.2 PRODUCTS

A. Products, General

- 1. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 - a. Provide tile complying with Standard grade requirements unless otherwise indicated.

2. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 1.2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.
3. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
4. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.
 - a. Where tile is indicated for installation in swimming pools, on exteriors or in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.
5. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

B. Tile Products

1. Tile Type: Factory-mounted unglazed **OR** glazed, **as directed**, ceramic mosaic tile.
 - a. Composition: Porcelain **OR** Impervious natural clay or porcelain **OR** Vitreous or impervious natural clay or porcelain, **as directed**.
 - b. Module Size: **1 by 1 inch (25.4 by 25.4 mm) OR 1 by 2 inches (25.4 by 50.8 mm) OR 2 by 2 inches (50.8 by 50.8 mm), as directed.**
 - c. Thickness: **1/4 inch (6.35 mm).**
 - d. Face: Plain **OR** Pattern of design indicated, **as directed**, with cushion edges.
 - e. Surface (for unglazed tile): Smooth, without **OR** Slip-resistant, with, **as directed**, abrasive admixture.
 - f. Finish (for glazed tile): Bright, opaque **OR** Bright, clear **OR** Mat, opaque **OR** Mat, clear **OR** Semimat, opaque **OR** Semimat, clear **OR** Vellum, opaque **OR** Vellum, clear **OR** Crystalline, **as directed**, glaze.
 - g. Tile Color and Pattern: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
 - h. Grout Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
 - i. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile, **as directed**. Provide shapes as follows, selected from manufacturer's standard shapes:
 - 1) Base Cove: Cove, module size **1 by 1 inch (25.4 by 25.4 mm) OR 2 by 1 inch (50.8 by 25.4 mm), as directed.**
 - 2) Base Cap for Portland Cement Mortar Installations: Bead (bullnose), module size **1 by 1 inch (25.4 by 25.4 mm) OR 2 by 1 inch (50.8 by 25.4 mm), as directed.**
 - 3) Base Cap for Thin-Set Mortar Installations: Surface bullnose, module size **1 by 1 inch (25.4 by 25.4 mm) OR 2 by 1 inch (50.8 by 25.4 mm) OR 2 by 2 inches (50.8 by 50.8 mm), as directed.**
 - 4) Wainscot Cap for Portland Cement Mortar Installations: Bead (bullnose), module size **1 by 1 inch (25.4 by 25.4 mm) OR 2 by 1 inch (50.8 by 25.4 mm), as directed.**
 - 5) Wainscot Cap for Thin-Set Mortar Installations: Surface bullnose, module size **1 by 1 inch (25.4 by 25.4 mm) OR 2 by 1 inch (50.8 by 25.4 mm) OR 2 by 2 inches (50.8 by 50.8 mm), as directed.**
 - 6) Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
 - 7) External Corners for Portland Cement Mortar Installations: Bead (bullnose), module size **1 by 1 inch (25.4 by 25.4 mm) OR 2 by 1 inch (50.8 by 25.4 mm), as directed.**
 - 8) External Corners for Thin-Set Mortar Installations: Surface bullnose, module size **1 by 1 inch (25.4 by 25.4 mm) OR 2 by 1 inch (50.8 by 25.4 mm) OR 2 by 2 inches (50.8 by 50.8 mm), as directed.**

- 9) Internal Corners: Cove, module size **1 by 1 inch (25.4 by 25.4 mm)** **OR 2 by 1 inch (50.8 by 25.4 mm)**, **as directed**.
OR
 Internal Corners: Field-butt square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.
- 10) Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from **1/2 to 1/4 inch (12.7 to 6.35 mm)** across nominal **4-inch (100-mm)** dimension.
2. Tile Type: Unglazed **OR** Glazed, **as directed**, square-edged quarry tile.
 - a. Face Size: **3 by 3 inches (76 by 76 mm)** **OR 4 by 4 inches (102 by 102 mm)** **OR 6 by 3 inches (152 by 76 mm)** **OR 6 by 6 inches (152 by 152 mm)** **OR 8 by 3-7/8 inches (203 by 98 mm)** **OR 8 by 8 inches (203 by 203 mm)**, **as directed**.
 - b. Thickness: **3/8 inch (9.5 mm)** **OR 1/2 inch (12.7 mm)** **OR 3/4 inch (19 mm)**, **as directed**.
 - c. Wearing Surface (for unglazed tile): Nonabrasive, smooth **OR** Abrasive aggregate embedded in surface, **as directed**.
 - d. Finish (for glazed tile): Bright, opaque **OR** Bright, clear **OR** Mat, opaque **OR** Mat, clear **OR** Semimat, opaque **OR** Semimat, clear **OR** Vellum, opaque **OR** Vellum, clear **OR** Crystalline, **as directed**, glaze.
 - e. Tile Color and Pattern: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
 - f. Grout Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
 - g. For furan-grouted quarry tile, precoat with temporary protective coating.
 - h. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile, **as directed**. Provide shapes as follows, selected from manufacturer's standard shapes:
 - 1) Base: Coved with surface bullnose top edge, **as directed**, face size **6 by 6 inches (152 by 152 mm)** **OR 8 by 3-7/8 inches (203 by 98 mm)**, **as directed**.
 - 2) Wainscot Cap: Surface bullnose, face size **6 by 6 inches (152 by 152 mm)** **OR 8 by 3-7/8 inches (203 by 98 mm)**, **as directed**.
 - 3) Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
3. Tile Type: Unglazed **OR** Glazed, **as directed**, paver tile.
 - a. Composition: Porcelain **OR** Impervious natural clay or porcelain **OR** Vitreous or impervious natural clay or porcelain **OR** Natural clay or porcelain, **as directed**.
 - b. Face Size: **3 by 3 inches (76 by 76 mm)** **OR 4 by 4 inches (102 by 102 mm)** **OR 6 by 6 inches (152 by 152 mm)** **OR 7-3/4 by 3-7/8 inches (197 by 98 mm)** **OR 7-7/8 by 7-7/8 inches (200 by 200 mm)** **OR 11-13/16 by 11-13/16 inches (300 by 300 mm)** **OR 165 by 333 mm** **OR 200 by 250 mm** **OR 250 by 250 mm** **OR 165 by 333 mm** **OR 333 by 333 mm** **OR 400 by 400 mm**, **as directed**.
 - c. Thickness: **1/4 inch (6.35 mm)** **OR 3/8 inch (9.5 mm)** **OR 1/2 inch (12.7 mm)**, **as directed**.
 - d. Face: Plain with square or cushion edges **OR** Plain with square edges **OR** Plain with cushion edges **OR** Pattern of design indicated, with square or cushion edges **OR** As indicated, **as directed**.
 - e. Finish (for glazed tile): Bright, opaque **OR** Bright, clear **OR** Mat, opaque **OR** Mat, clear **OR** Semimat, opaque **OR** Semimat, clear **OR** Vellum, opaque **OR** Vellum, clear **OR** Crystalline, **as directed**, glaze.
 - f. Tile Color and Pattern: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
 - g. Grout Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
4. Tile Type: Glazed wall tile **OR** Decorative thin wall tile, **as directed**.

- a. Module Size: 4-1/4 by 4-1/4 inches (108 by 108 mm) OR 6 by 4-1/4 inches (152 by 108 mm) OR 6 by 6 inches (152 by 152 mm) OR 200 by 200 mm OR 250 by 250 mm OR 200 by 300 mm, **as directed**.
 - b. Thickness: 5/16 inch (8 mm).
 - c. Face: Plain with modified square edges or cushion edges OR Plain with modified square edges OR Plain with cushion edges OR Pattern of design indicated, with manufacturer's standard edges, **as directed**.
 - d. Finish: Bright, opaque OR Bright, clear OR Mat, opaque OR Mat, clear OR Semimat, opaque OR Semimat, clear OR Vellum, opaque OR Vellum, clear OR Crystalline, **as directed**, glaze.
 - e. Tile Color and Pattern: As indicated by manufacturer's designations OR As selected from manufacturer's full range, **as directed**.
 - f. Grout Color: As indicated by manufacturer's designations OR As selected from manufacturer's full range, **as directed**.
 - g. Mounting: Factory, back mounted.
 - h. Mounting: PregROUTED sheets of tiles factory assembled and grouted with manufacturer's standard white silicone rubber.
 - i. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile, **as directed**. Provide shapes as follows, selected from manufacturer's standard shapes:
 - 1) Base for Portland Cement Mortar Installations: Coved, module size 4-1/4 by 4-1/4 inches (108 by 108 mm) OR 6 by 6 inches (152 by 152 mm) OR 6 by 3-3/4 inches (152 by 95 mm), **as directed**.
 - 2) Base for Thin-Set Mortar Installations: Straight, module size 4-1/4 by 4-1/4 inches (108 by 108 mm) OR 6 by 6 inches (152 by 152 mm) OR 6 by 2 inches (152 by 51 mm), **as directed**.
 - 3) Wainscot Cap for Portland Cement Mortar Installations: Bullnose cap, module size 4-1/4 by 4-1/4 inches (108 by 108 mm) OR 6 by 6 inches (152 by 152 mm) OR 6 by 2 inches (152 by 51 mm), **as directed**.
 - 4) Wainscot Cap for Thin-Set Mortar Installations: Surface bullnose, module size 4-1/4 by 4-1/4 inches (108 by 108 mm) OR 6 by 6 inches (152 by 152 mm) OR 6 by 2 inches (152 by 51 mm), **as directed**.
 - 5) Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
 - 6) External Corners for Portland Cement Mortar Installations: Bullnose shape with radius of at least 3/4 inch (19 mm) unless otherwise indicated.
 - 7) External Corners for Thin-Set Mortar Installations: Surface bullnose, same size as adjoining flat tile.
 - 8) Internal Corners: Field-butt square corners. For coved base and cap use angle pieces designed to fit with stretcher shapes.
 5. Accessories: Provide vitreous china accessories of type and size indicated, suitable for installing by same method as adjoining wall tile.
 - a. One soap holder with grab handle, **as directed**, for each shower and tub indicated.
 - b. One paper holder at each water closet.
 - c. Color and Finish: Match adjoining glazed wall tile OR As indicated by manufacturer's designations OR As selected from manufacturer's full range OR White, bright glaze, **as directed**.
- C. Thresholds
1. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
 - a. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch (1.5 mm) above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch (12.7 mm) or less above adjacent floor surface.
 2. Granite Thresholds: ASTM C 615, with polished OR honed, **as directed**, finish.

- a. Description: Uniform, fine **OR** medium, **as directed**, -grained, white **OR** gray **OR** black, **as directed**, stone without veining.
OR
Description: Match sample.
 3. Marble Thresholds: ASTM C 503, with a minimum abrasion resistance of 10 **OR** 12, **as directed**, per ASTM C 1353 or ASTM C 241 and with honed finish.
 - a. Description: Uniform, fine- to medium-grained white stone with gray veining.
OR
Description: Match sample.
 4. Slate Thresholds: ASTM C 629, Classification I Exterior **OR** II Interior, **as directed**, with fine, even grain and honed finish.
 - a. Description: Uniform, black **OR** blue-black **OR** gray **OR** blue-gray **OR** green, **as directed**, stone and unfading.
OR
Description: Match sample.
- D. Tile Backing Panels
 1. Cementitious Backer Units: ANSI A118.9 or ASTM C 1325, in maximum lengths available to minimize end-to-end butt joints.
 - a. Thickness: **1/4 inch (6.4 mm) OR 1/2 inch (12.7 mm) OR 5/8 inch (15.9 mm) OR** As indicated, **as directed**.
 2. Fiber-Cement Underlayment: ASTM C 1288, in maximum lengths available to minimize end-to-end butt joints.
 - a. Thickness: **1/4 inch (6.4 mm) OR 1/2 inch (12.7 mm) OR** As indicated, **as directed**.
- E. Waterproof Membrane
 1. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
 2. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; **0.030-inch (0.76-mm)** nominal thickness.
 3. PVC Sheet: Two layers of PVC sheet heat-fused together and to facings of nonwoven polyester; **0.040-inch (1.01-mm)** nominal thickness.
 4. Polyethylene Sheet: Polyethylene faced on both sides with fleece webbing; **0.008-inch (0.203-mm)** nominal thickness.
 5. Fabric-Reinforced, Modified-Bituminous Sheet: Self-adhering, SBS-modified-bituminous sheet with woven reinforcement facing; **0.040-inch (1.01-mm)** nominal thickness.
 6. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.
 7. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
 8. Latex-Portland Cement: Flexible mortar consisting of cement-based mix and latex additive.
 9. Urethane Waterproofing and Tile-Setting Adhesive: One-part, liquid-applied urethane, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), in a consistency suitable for trowel application and intended for use as both waterproofing and tile-setting adhesive in a two-step process.
- F. Crack Isolation Membrane
 1. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.12 for standard **OR** high, **as directed**, performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
 2. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; **0.030-inch (0.76-mm)** nominal thickness.
 3. PVC Sheet: Two layers of PVC sheet heat-fused together and to facings of nonwoven polyester; **0.040-inch (1.01-mm)** nominal thickness.

4. Polyethylene Sheet: Polyethylene faced on both sides with fleece webbing; **0.008-inch (0.203-mm)** nominal thickness.
5. Corrugated Polyethylene: Corrugated polyethylene with dovetail-shaped corrugations and with anchoring webbing on the underside; **3/16-inch (4-mm)** nominal thickness.
6. Fabric-Reinforced, Modified-Bituminous Sheet: Self-adhering, modified-bituminous sheet with fabric reinforcement facing; **0.040-inch (1.01-mm)** nominal thickness.
7. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and fabric reinforcement.
8. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
9. Latex-Portland Cement: Flexible mortar consisting of cement-based mix and latex additive.
10. Urethane Crack Isolation Membrane and Tile-Setting Adhesive: One-part, liquid-applied urethane, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), in a consistency suitable for trowel application and intended for use as both waterproofing and tile-setting adhesive in a two-step process.

G. Setting Materials

1. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
 - a. Cleavage Membrane: Asphalt felt, ASTM D 226, Type I (No. 15); or polyethylene sheeting, ASTM D 4397, **4.0 mils (0.1 mm)** thick.
 - b. Reinforcing Wire Fabric: Galvanized, welded wire fabric, **2 by 2 inches (50.8 by 50.8 mm)** by **0.062-inch (1.57-mm)** diameter; comply with ASTM A 1064 and ASTM A 82 except for minimum wire size.
 - c. Expanded Metal Lath: Diamond-mesh lath complying with ASTM C 847.
 - 1) Base Metal and Finish for Interior Applications: Uncoated or zinc-coated (galvanized) steel sheet, with uncoated steel sheet painted after fabrication into lath.
 - 2) Base Metal and Finish for Exterior Applications: Zinc-coated (galvanized) steel sheet.
 - 3) Configuration over Studs and Furring: Flat.
 - 4) Configuration over Solid Surfaces: Self furring.
 - 5) Weight: **2.5 lb/sq. yd. (1.4 kg/sq. m)** **OR 3.4 lb/sq. yd. (1.8 kg/sq. m), as directed.**
 - d. Latex Additive: Manufacturer's standard, acrylic resin or styrene-butadiene-rubber water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.
2. Dry-Set Portland Cement Mortar (Thin Set): ANSI A118.1.
 - a. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.1.
3. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.
 - a. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
OR
Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
 - b. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
4. Medium-Bed, Latex-Portland Cement Mortar: Comply with requirements in ANSI A118.4. Provide product that is approved by manufacturer for application thickness of **5/8 inch (16 mm)**.
 - a. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
OR
Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
5. EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar (Thin Set): ANSI A118.11.
 - a. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.

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- half-hard brass **OR** white zinc alloy **OR** nickel silver **OR** stainless-steel, ASTM A 666, 300 Series, **as directed**, exposed-edge material.
3. Temporary Protective Coating: Either product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.
 - a. Petroleum paraffin wax, fully refined and odorless, containing at least 0.5 percent oil with a melting point of **120 to 140 deg F (49 to 60 deg C)** per ASTM D 87.
 - b. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.
 4. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
 5. Grout Sealer: Manufacturer's standard silicone product for sealing grout joints and that does not change color or appearance of grout.
- K. Mixing Mortars And Grout
1. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
 2. Add materials, water, and additives in accurate proportions.
 3. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

1.3 EXECUTION

A. Examination

1. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
 - a. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 - b. Verify that concrete substrates for tile floors installed with adhesives, bonded mortar bed or thin-set mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - 1) Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - 2) Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 - c. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 - d. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation

1. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with adhesives or thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
2. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped **1/4 inch per foot (1:50)** toward drains.
3. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from

other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

4. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

C. Tile Installation

1. Comply with TCA's "Handbook for Ceramic Tile Installation" for TCA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
 - a. For the following installations, follow procedures in the ANSI A108 Series of tile installation standards for providing 95 percent mortar coverage:
 - 1) Exterior tile floors.
 - 2) Tile floors in wet areas.
 - 3) Tile swimming pool decks.
 - 4) Tile floors in laundries.
 - 5) Tile floors composed of tiles **8 by 8 inches (200 by 200 mm)** or larger.
 - 6) Tile floors composed of rib-backed tiles.
2. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
3. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
4. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
 - a. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
 - b. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
 - c. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
5. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 - a. Ceramic Mosaic Tile: **1/16 inch (1.6 mm)**.
 - b. Porcelain Tile: **1/4 inch (6.4 mm) OR 3/8 inch (9.5 mm), as directed.**
 - c. Quarry Tile: **1/4 inch (6.35 mm) OR 3/8 inch (9.5 mm), as directed.**
 - d. Paver Tile: **1/4 inch (6.35 mm) OR 3/8 inch (9.5 mm), as directed.**
 - e. Glazed Wall Tile: **1/16 inch (1.6 mm)**.
 - f. Decorative Thin Wall Tile: **1/16 inch (1.6 mm)**.
6. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
7. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - a. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
 - b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".
8. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
 - a. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in latex-portland cement mortar (thin set).

- b. Do not extend cleavage membrane, waterproofing or crack isolation membrane under thresholds set in dry-set portland cement or latex-portland cement mortar. Fill joints between such thresholds and adjoining tile set on cleavage membrane, waterproofing or crack isolation membrane with elastomeric sealant.
 - 9. Metal Edge Strips: Install at locations indicated **OR** where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile **OR** where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated, **as directed**.
 - 10. Grout Sealer: Apply grout sealer to cementitious grout joints in tile floors according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.
- D. Tile Backing Panel Installation
 - 1. Install cementitious backer units and fiber-cement underlayment and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use latex-portland cement mortar for bonding material unless otherwise directed in manufacturer's written instructions.
- E. Waterproofing Installation
 - 1. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness and bonded securely to substrate.
 - 2. Do not install tile or setting materials over waterproofing until waterproofing has cured and been tested to determine that it is watertight.
- F. Crack Isolation Membrane Installation
 - 1. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness and bonded securely to substrate.
 - 2. Do not install tile or setting materials over crack isolation membrane until membrane has cured.
- G. Cleaning And Protecting
 - 1. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - a. Remove epoxy and latex-portland cement grout residue from tile as soon as possible.
 - b. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
 - c. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.
 - 2. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
 - 3. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
 - 4. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.
- H. Exterior Tile Installation Schedule
 - 1. Exterior Floor Installations:
 - a. Tile Installation F101: Cement mortar bed (thickset) bonded to concrete **OR** over waterproof membrane on concrete **OR** over waterproof membrane on concrete where indicated and bonded to concrete where membrane is not indicated, **as directed**; TCA F101 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
 - 1) Tile Type: as directed by the Owner.

- 2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
- 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
- b. Tile Installation F102: Thin-set mortar on concrete **OR** over waterproof membrane on concrete **OR** over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated, **as directed**; TCA F102.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
2. Exterior Wall Installations, Masonry or Concrete:
 - a. Tile Installation W201: Cement mortar bed (thickset) on metal lath over waterproof membrane; TCA W201 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
 - 1) Tile Type: as directed by the Owner.
 - 2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
 - b. Tile Installation W202: Thin-set mortar; TCA W202.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
- I. Interior Tile Installation Schedule
 1. Interior Floor Installations, Concrete Subfloor:
 - a. Tile Installation F111: Cement mortar bed (thickset) with cleavage membrane; TCA F111 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
 - b. Tile Installation F112: Cement mortar bed (thickset) bonded to concrete; TCA F112 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
 - c. Tile Installation F113: Thin-set mortar; TCA F113.
 - 1) Tile Type: as directed by the Owner.

- 2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
 - d. Tile Installation F114: Cement mortar bed (thickset) with cleavage membrane; epoxy **OR** furan, **as directed**, grout; TCA F114 and ANSI A108.1B.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 3) Grout: Water-cleanable epoxy **OR** Chemical-resistant furan, **as directed**, grout.
 - e. Tile Installation F115: Thin-set mortar; epoxy **OR** furan, **as directed**, grout; TCA F115.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 3) Grout: Water-cleanable epoxy **OR** Chemical-resistant furan, **as directed**, grout.
 - f. Tile Installation F116: Organic adhesive **OR** Water-cleanable, tile-setting epoxy, **as directed**; TCA F116.
 - 1) Tile Type: as directed by the Owner.
 - 2) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
 - g. Tile Installation F121: Cement mortar bed (thickset) on waterproof membrane; TCA F121 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
 - h. Tile Installation F122: Thin-set mortar on waterproof membrane; TCA F122.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 3) Grout: Polymer-modified sanded **OR** unsanded, **as directed**, grout.
 - i. Tile Installation F125A: Thin-set mortar on crack isolation membrane; TCA F125A.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 3) Grout: Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
 - j. Tile Installation F131: Water-cleanable, tile-setting epoxy; epoxy grout; TCA F131.
 - 1) Tile Type: as directed by the Owner.
 - 2) Grout: Water-cleanable epoxy grout.
 - k. Tile Installation F132: Water-cleanable, tile-setting epoxy on cured cement mortar bed bonded to concrete subfloor **OR** installed over cleavage membrane, **as directed**; epoxy grout; TCA F132.
 - 1) Tile Type: as directed by the Owner.
 - 2) Grout: Water-cleanable epoxy grout.
 - l. Tile Installation F133: Chemical-resistant furan mortar **OR** Water-cleanable, tile-setting epoxy, **as directed**; furan grout. TCA F133 except use water-cleanable, tile-setting epoxy instead of chemical-resistant furan mortar for setting tile.
 - 1) Tile Type: as directed by the Owner.
 - 2) Grout: Chemical-resistant furan grout.
2. Interior Floor Installations, Wood Subfloor:

- a. Tile Installation F121: Cement mortar bed (thickset) on waterproof membrane; TCA F121 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
- b. Tile Installation F141: Cement mortar bed (thickset) with cleavage membrane; TCA F141 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
- c. Tile Installation F142: Organic adhesive; TCA F142.
 - 1) Tile Type: as directed by the Owner.
 - 2) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
- d. Tile Installation F143: Water-cleanable, tile-setting epoxy; epoxy grout; TCA F143.
 - 1) Tile Type: as directed by the Owner.
 - 2) Grout: Water-cleanable epoxy grout.
- e. Tile Installation F144: Thin-set mortar on cementitious backer units or fiber cement underlayment; TCA F144.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
- f. Tile Installation F150/160: Thin-set mortar on exterior-glue plywood; TCA F150 or TCA F160.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: EGP latex-portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
3. Interior Radiant Heat Floor Installations, Concrete Subfloor:
 - a. Tile Installation RH110: Thin-set mortar on crack isolation membrane; hydronic piping installed in concrete; TCA RH110.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
 - b. Tile Installation RH115: Thin-set mortar; electric radiant system encapsulated in thin-set mortar; TCA RH115.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.

- 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
- c. Tile Installation RH116: Thin-set mortar on crack isolation membrane; electric radiant system encapsulated in cementitious self-leveling underlayment; TCA RH116.
 - 1) Tile Type: as directed by the Owner.
 - 2) Cementitious Self-Leveling Underlayment: Specified in Division 03 Section "Hydraulic Cement Underlayment".
 - 3) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
4. Interior Radiant Heat Floor Installations, Wood Subfloor:
 - a. Tile Installation RH130: Thin-set mortar on exterior-glue plywood; electric radiant system encapsulated in thin-set mortar; TCA RH130.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: EGP latex-portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
 - b. Tile Installation RH135: Thin-set mortar on cementitious backer units or fiber cement underlayment; electric radiant system encapsulated in thin-set mortar; TCA RH135.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
 - c. Tile Installation RH140: Thin-set mortar on crack isolation membrane; electric radiant system encapsulated in cementitious self-leveling underlayment; TCA RH140.
 - 1) Tile Type: as directed by the Owner.
 - 2) Cementitious Self-Leveling Underlayment: Specified in Division 03 Section "Hydraulic Cement Underlayment".
 - 3) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
5. Interior Wall Installations, Masonry or Concrete:
 - a. Tile Installation W202: Thin-set mortar; TCA W202.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
 - b. Tile Installation W211: Cement mortar bed (thickset) bonded to substrate; TCA W211 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
 - 1) Tile Type: as directed by the Owner.
 - 2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.

- 4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
- c. Tile Installation W221: Cement mortar bed (thickset) on metal lath over waterproof membrane, **as directed**; TCA W221 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
 - 1) Tile Type: as directed by the Owner.
 - 2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
- d. Tile Installation W222: One-coat cement mortar bed (thickset) on metal lath over waterproof membrane, **as directed**; TCA W222 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
 - 1) Tile Type: as directed by the Owner.
 - 2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
- e. Tile Installation W223: Organic adhesive; TCA W223.
 - 1) Tile Type: as directed by the Owner.
 - 2) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
6. Interior Wall Installations, Wood Studs or Furring:
 - a. Tile Installation W221: Cement mortar bed (thickset) over waterproof membrane, **as directed**, on solid backing; TCA W221 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
 - 1) Tile Type: as directed by the Owner.
 - 2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
 - b. Tile Installation W222: One-coat cement mortar bed (thickset) over waterproof membrane, **as directed**, on solid backing; TCA W222 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
 - 1) Tile Type: as directed by the Owner.
 - 2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
 - c. Tile Installation W223: Organic adhesive on solid backing; TCA W223.
 - 1) Tile Type: as directed by the Owner.

- 2) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
- d. Tile Installation W231: Cement mortar bed (thickset); TCA W231 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
 - 1) Tile Type: as directed by the Owner.
 - 2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
- e. Tile Installation W243: Thin-set mortar on gypsum board; TCA W243.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
- f. Tile Installation W244: Thin-set mortar on cementitious backer units or fiber cement underlayment over cleavage membrane, **as directed**; TCA W244.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
- g. Tile Installation W245: Thin-set mortar **OR** Organic adhesive, **as directed**, on coated glass-mat, water-resistant gypsum backer board; TCA W245.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
7. Interior Wall Installations, Metal Studs or Furring:
 - a. Tile Installation W221: Cement mortar bed (thickset) over waterproof membrane, **as directed**, on solid backing; TCA W221 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
 - 1) Tile Type: as directed by the Owner.
 - 2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
 - b. Tile Installation W222: One-coat cement mortar bed (thickset) over waterproof membrane, **as directed**, on solid backing; TCA W222 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
 - 1) Tile Type: as directed by the Owner.
 - 2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

- c. Tile Installation W223: Organic adhesive on solid backing; TCA W223.
 - 1) Tile Type: as directed by the Owner.
 - 2) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
- d. Tile Installation W241: Cement mortar bed (thickset); TCA W241 and ANSI A108.1B.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
- e. Tile Installation W242: Organic adhesive on gypsum board; TCA W242.
 - 1) Tile Type: as directed by the Owner.
 - 2) Grout: Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
- f. Tile Installation W243: Thin-set mortar on gypsum board; TCA W243.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
- g. Tile Installation W244: Thin-set mortar on cementitious backer units or fiber cement underlayment over cleavage membrane, **as directed**; TCA W244.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
- h. Tile Installation W245: Thin-set mortar **OR** Organic adhesive, **as directed**, on coated glass-mat, water-resistant gypsum backer board; TCA W245.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
- 8. Bathtub Wall Installations, Wood **OR** Metal, **as directed**, Studs or Furring:
 - a. Tile Installation B413: Thin-set mortar **OR** Organic adhesive, **as directed**, on water-resistant gypsum board; TCA B413.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
- 9. Bathtub/Shower Wall Installations, Wood **OR** Metal, **as directed**, Studs or Furring:
 - a. Tile Installation B411: Cement mortar bed (thickset); TCA B411 and ANSI A108.1A.
 - 1) Tile Type: as directed by the Owner.
 - 2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
 - b. Tile Installation B412: Thin-set mortar on cementitious backer units or fiber cement underlayment; TCA B412.
 - 1) Tile Type: as directed by the Owner.

- 2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
- 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
- c. Tile Installation B419: Thin-set mortar **OR** Organic adhesive, **as directed**, on coated glass-mat, water-resistant backer board; TCA B419.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
10. Shower Receptor and Wall Installations, Concrete or Masonry:
 - a. Tile Installation B414: Cement mortar bed (thickset); TCA B414 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
 - 1) Tile Type: as directed by the Owner.
 - 2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
 - b. Tile Installation B421: Thin-set mortar on waterproof membrane; TCA B421.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Latex-portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
 - c. Tile Installation B422: Thin-set mortar on waterproof membrane with integrated bonding flange for bonded membranes; TCA B422.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
11. Shower Receptor and Wall Installations, Wood **OR** Metal, **as directed**, Studs or Furring:
 - a. Tile Installation B414: Cement mortar bed (thickset); TCA B414 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
 - 1) Tile Type: as directed by the Owner.
 - 2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
 - b. Tile Installation B415: Thin-set mortar on cementitious backer units or fiber cement underlayment; TCA B415.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
 - c. Tile Installation B420: Thin-set mortar on coated glass-mat, water-resistant backer board; TCA B420.
 - 1) Tile Type: as directed by the Owner.

- 2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
- 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
- d. Tile Installation B421: Thin-set mortar on waterproof membrane over cementitious backer units or fiber cement underlayment; TCA B421.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Latex-portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
- e. Tile Installation B422: Thin-set mortar on waterproof membrane over cementitious backer units or fiber cement underlayment with integrated bonding flange for bonded membranes; TCA B422.
 - 1) Tile Type: as directed by the Owner.
 - 2) Thin-Set Mortar: Latex-portland cement mortar.
 - 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

END OF SECTION 09 01 30 91

SECTION 09 01 60 91 - PORTLAND CEMENT TERRAZZO FLOORING

1.1 GENERAL

A. Description Of Work

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

B. Summary

1. Section Includes:
 - a. Poured-in-place portland cement terrazzo flooring and base.
 - b. Poured-in-place rustic terrazzo flooring.
 - c. Precast terrazzo units.

C. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
 - a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For marble chips, aggregates, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - 1) Include statement that indicates cost for each product having recycled content.
 - b. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
3. Shop Drawings: Include terrazzo installation requirements. Include plans, elevations, sections, component details, and attachments to other work.
4. Samples: For each type, material, color, and pattern of terrazzo and accessory required showing the full range of color, texture, and pattern variations expected
5. Qualification data.
6. Material certificates.
7. Maintenance data.

D. Quality Assurance

1. Installer Qualifications: An installer who is a contractor member of NTMA.
2. NTMA Standards: Comply with NTMA's "Terrazzo Specifications and Design Guide" and with written recommendations for terrazzo type indicated unless more stringent requirements are specified.
3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling

1. Deliver materials to Project site in supplier's original wrappings and containers, labeled with source's or manufacturer's name, material or product brand name, and lot number if any.
2. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

F. Project Conditions

1. Environmental Limitations: Maintain temperature above **50 deg F (10 deg C)** for 48 hours before and during terrazzo installation.
2. Weather Limitations: Proceed with rustic terrazzo installation only when forecasted weather conditions permit work to be performed according to NTMA's written recommendations and temperatures remain above **45 deg F (7.2 deg C)**.
3. Field Measurements: Verify actual dimensions of construction contiguous with precast terrazzo by field measurements before fabrication.

4. Control and collect dust produced by grinding operations. Protect adjacent construction from detrimental effects of grinding operations.
 - a. Provide dustproof partitions and temporary enclosures to limit dust migration and to isolate areas from noise.

1.2 PRODUCTS

A. Portland Cement Terrazzo

1. Portland Cement Terrazzo Type: Sand cushion **OR** Structural **OR** Bonded **OR** Monolithic **OR** Installed over metal deck, **as directed**.
2. Materials:
 - a. Portland Cement: ASTM C 150, Type 1.
 - 1) Color for Exposed Matrix: As required by mix indicated **OR** White **OR** Gray, **as directed**.
 - b. Water: Potable.
 - c. Sand: ASTM C 33.
 - d. Marble Chips **OR** Aggregates, **as directed**: Complying with NTMA gradation standards for mix indicated and containing no deleterious or foreign matter.
 - 1) Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C 131 and ASTM C 535, **as directed**.
 - 2) 24-Hour Absorption Rate: Less than 0.75 percent.
 - 3) Dust Content: Less than 1.0 percent by weight.
 - e. Matrix Pigments: Pure mineral or synthetic pigments, alkali resistant, durable under exposure to sunlight, and compatible with terrazzo matrix.
 - f. Bonding Agent: Neat portland cement or epoxy or acrylic bonding agents formulated for use with topping indicated.
 - g. Underbed Reinforcement: Galvanized welded-wire reinforcement, **2 by 2 inches (51 by 51 mm)** by **0.062-inch- (1.57-mm-)** diameter wire, complying with ASTM A 1064 and ASTM A 82, except for minimum wire size.
 - h. Isolation Membrane: Polyethylene sheeting, ASTM D 2103, Type 13300, **4 mils (0.1 mm)** thick; or unperforated asphalt felt, ASTM D 226, Type I (No. 15).
3. Mixes:
 - a. Underbed (for structural portland cement terrazzo or portland cement terrazzo installed over metal deck): Structural-concrete underbed as specified in Division 03 Section "Cast-in-place Concrete".
 - b. Underbed (for sand-cushion or bonded portland cement terrazzo): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for component proportions and mixing.
 - c. Portland Cement Terrazzo (below for NTMA-formulated design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for matrix and marble-chip proportions and mixing.
 - 1) Formulated Mix Color and Pattern: As selected from NTMA standard-terrazzo plates **OR** As selected from NTMA Venetian-terrazzo plates, **as directed**.
 - d. Portland Cement Terrazzo (for custom design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for matrix and marble-chip **OR** aggregate, **as directed**, proportions and mixing.
 - 1) Custom Mix Color and Pattern: Match sample **OR** Match existing, **as directed**.

B. Rustic Terrazzo

1. Rustic Terrazzo Type: Structural **OR** Bonded **OR** Monolithic **OR** Unbonded, **as directed**.
2. Materials:
 - a. Portland Cement: ASTM C 150, Type 1.
 - 1) Color for Exposed Matrix: As required by mix indicated.
 - b. Water: Potable.

- c. Sand: ASTM C 33.
 - d. Marble Chips **OR** Aggregates, **as directed**: As required for mix indicated, sizes complying with NTMA gradation standards, 0.25 percent maximum 24-hour absorption rate, and containing no deleterious or foreign matter.
 - e. Matrix Pigments: Pure mineral or synthetic pigments, alkali resistant, durable under exposure to sunlight and weather, and compatible with matrix binder.
 - f. Air-Entraining Agent (for underbed of structural, bonded, or unbonded rustic terrazzo): Complying with NTMA's written recommendations and recommended by supplier for intended use.
 - g. Underbed Bonding Agent (for bonded rustic terrazzo): Neat portland cement.
 - h. Topping Bonding Agent (for monolithic rustic terrazzo): Neat portland cement, or epoxy or acrylic bonding agents formulated for use with topping indicated.
 - i. Isolation Membrane (for unbonded rustic terrazzo): Polyethylene sheeting, ASTM D 2103, Type 13300, **4 mils (0.1 mm)** thick.
3. Mixes:
- a. Underbed (for structural or unbonded rustic terrazzo): Structural-concrete underbed as specified in Division 03 Section "Cast-in-place Concrete".
 - b. Underbed (for bonded rustic terrazzo): Comply with NTMA's "Terrazzo Specifications and Design Guide" for component proportions and mixing.
 - 1) Exterior Applications: Provide air-entraining agent.
 - c. Rustic Terrazzo (for NTMA-formulated design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for matrix and marble-chip proportions and mixing.
 - 1) Formulated Mix Color and Pattern: As selected from NTMA rustic-terrazzo plates.
 - d. Rustic Terrazzo (for custom design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for matrix and marble-chip **OR** aggregate, **as directed**, proportions and mixing.
 - 1) Custom Mix Color and Pattern: Match sample **OR** Match existing, **as directed**.
- C. Strip Materials
1. Standard Divider Strips: One-piece, flat-type strips for grouting into sawed joints prepared in concrete slab or underbed.
 - a. Material: As indicated **OR** White-zinc alloy **OR** Brass, **as directed**.
 - b. Depth: As indicated **OR 3/4 inch (19 mm) OR 1-1/4 inches (32 mm) OR 2 inches (51 mm), as directed**.
 - c. Width: As indicated **OR 0.05 inch (1.27 mm) OR 1/8 inch (3.2 mm) OR 1/4 inch (6.4 mm), as directed**.
 2. Heavy-Top Divider Strips: One-piece, flat-type strips for grouting into sawed joints prepared in concrete slab or underbed.
 - a. Base-Section Material: As indicated **OR** White-zinc alloy **OR** Galvanized steel, **as directed**.
 - b. Top-Section Material: As indicated **OR** White-zinc alloy **OR** Brass **OR** Plastic, in color selected from manufacturer's full range, **as directed**.
 - c. Depth: As indicated **OR 3/4 inch (19 mm) OR 1-1/4 inches (32 mm) OR 2 inches (51 mm), as directed**.
 - d. Top-Section Width: As indicated **OR 1/8 inch (3.2 mm) OR 1/4 inch (6.4 mm) OR 1/2 inch (12.7 mm), as directed**.
 3. Heavy-Top Angle Divider Strips: One-piece, L-type angle strips with anchoring device and in depth required for topping thickness indicated.
 - a. Material: As indicated **OR** White-zinc alloy **OR** Brass **OR** Plastic, in color selected from manufacturer's full range, **as directed**.
 - b. Top-Section Width: As indicated **OR 1/8 inch (3.2 mm) OR 1/4 inch (6.4 mm) OR 3/8 inch (9.5 mm) OR 1/2 inch (12.7 mm), as directed**.
 4. Control-Joint Strips: Separate, double L-type angles, positioned back to back, that match material, thickness, and color of divider strips and in depth required for topping thickness indicated.

5. Expansion-Joint Strips (for structural portland cement terrazzo or for any type of rustic terrazzo): Brass **OR** Plastic strips in color selected from manufacturer's full range, **as directed**, with removable zip-strip top for installing sealant; in width indicated **OR** minimum **1/2 inch (12.7 mm)** wide, **as directed**.
6. Accessory Strips: Match divider strip width, material, and color unless otherwise indicated. Use the following types of accessory strips as required to provide a complete installation:
 - a. Base-bead strips for exposed top edge of terrazzo base.
 - b. Edge-bead strips for exposed edges of terrazzo.
 - c. Nosings for terrazzo stair treads and landings.
7. Abrasive Strips (for terrazzo stair treads and landings): Silicon carbide or aluminum oxide, or combination of both, in epoxy-resin binder and set in channel.
 - a. Width: **1/2 inch (12.7 mm)**.
 - b. Depth: As required by terrazzo thickness.
 - c. Length: **4 inches (100 mm)** less than stair width **OR** As indicated, **as directed**.
 - d. Color: As selected from manufacturer's full range.

D. Miscellaneous Accessories

1. Strip Adhesive: Adhesive recommended by manufacturer for this use.
 - a. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Anchoring Devices:
 - a. Strips: Provide mechanical anchoring devices for strip materials as required for secure attachment to substrate.
 - b. Precast Terrazzo: Provide mechanical anchoring devices as recommended by fabricator for proper anchorage and support of units for conditions of installation and support.
3. Isolation and Expansion-Joint Material: Closed-cell polyethylene foam, nonabsorbent to liquid water and gas, and nonoutgassing in unruptured state; butyl rubber; rubber; or cork; in width indicated **OR** minimum **1/2 inch (12.7 mm)** wide, **as directed**.
4. Portland Cement Terrazzo Cleaner: Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by cleaner manufacturer for use on terrazzo type indicated.
5. Rustic Terrazzo Cleaner: Solution of muriatic acid and water for use on terrazzo type indicated.
6. Sealer: Slip- and stain-resistant, penetrating-type sealer that is chemically neutral with pH factor between 7 and 10; does not affect color or physical properties of terrazzo; is recommended by sealer manufacturer; and complies with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated.
 - a. Rustic Terrazzo: Use solvent acrylic-type sealer.

E. Precast Terrazzo

1. Precast Terrazzo Base Units: Minimum **3/4-inch- (19-mm-)** thick, reinforced portland cement terrazzo units cast in maximum lengths possible, but not less than **36 inches (900 mm)**.
 - a. Type: As indicated **OR** Coved with minimum **3/4-inch (19-mm)** radius **OR** Straight **OR** Splayed, **as directed**.
 - b. Top Edge: Straight, unfinished if top edge is concealed **OR** Beveled with polished top surface **OR** Radius edge with polished top surface, **as directed**.
 - c. Metal Toe Strip (for coved-toe bases): Zinc **OR** Brass, **as directed**.
 - d. Outside Corner Units: With finished returned edges at outside corner.
 - e. Color, Pattern, and Finish: As selected from manufacturer's full range **OR** Match sample **OR** Match adjacent poured-in-place terrazzo flooring, **as directed**.
2. Precast Terrazzo Units for Stair Treads, Thresholds, Sills, Benches and Planters: Comply with NTMA's written recommendations for fabricating precast terrazzo units in sizes and profiles indicated. Reinforce units as required by unit sizes, profiles, and thicknesses and as recommended by manufacturer.
 - a. Stair Treads: Three-line **OR** Two-line **OR** One-line **OR** Abrasive nosing strip and two-line, **as directed**, abrasive inserts at nosings.

- b. Color, Pattern, and Finish: As selected from manufacturer's full range **OR** Match sample **OR** Match adjacent poured-in-place terrazzo flooring, **as directed**.
 - 3. Precast Terrazzo Finishing (for custom precast terrazzo components):
 - a. Finish exposed-to-view edges or reveals to match face finish.
 - b. Ease exposed edges to **1/8-inch (3-mm)** radius.

1.3 EXECUTION

A. Preparation

- 1. Clean substrates to produce clean, dry, and neutral substrate for terrazzo application.
 - a. Remove substances, including oil, grease, and curing compounds, that might impair bond of terrazzo system.
 - b. Roughen concrete substrates before installing terrazzo system according to NTMA's written recommendations.
- 2. Protect other work from dust generated by grinding operations. Control dust to prevent air pollution and comply with environmental protection regulations.
 - a. Erect and maintain temporary enclosures and other suitable methods to limit dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

B. Installation, General

- 1. Comply with NTMA's written recommendations for terrazzo and accessory installation.
- 2. Installation Tolerance: Limit variation in terrazzo surface from level to **1/4 inch in 10 feet (6 mm in 3 m)**; noncumulative.
- 3. Structural Portland Cement **OR** Structural Rustic **OR** Bonded Rustic **OR** Monolithic Rustic **OR** Unbonded Rustic, **as directed**, Terrazzo: Install isolation and expansion material where terrazzo and underbed abut **OR** terrazzo abuts, **as directed**, adjacent construction and directly above substrate expansion joints.
- 4. Underbed (for structural portland cement terrazzo or portland cement terrazzo installed over metal deck, or for structural or unbonded rustic terrazzo): Install structural-concrete underbed according to requirements specified in Division 03 Section "Cast-in-place Concrete".
- 5. Underbed (for sand-cushion or bonded portland cement terrazzo or for bonded rustic terrazzo):
 - a. Comply with NTMA's "Terrazzo Specifications and Design Guide" for underbed installation.
 - b. For sand-cushion portland cement terrazzo only:
 - 1) Cover entire surface to receive terrazzo with dusting of sand.
 - 2) Install isolation membrane over sand, overlapping ends and edges a minimum of **3 inches (75 mm)**.
 - 3) Install welded wire reinforcement, overlapping at edges and ends at least two squares. Stop mesh a minimum of **1 inch (25 mm)** short of expansion joints.
 - c. Place underbed and screed to elevation indicated below finished floor elevation.
- 6. Strip Materials:
 - a. Divider and Control-Joint Strips:
 - 1) Locate divider strips over each edge of steel beams and girders **OR** centered over steel beams and joists **OR** directly over control joints, breaks, and saw cuts in concrete slabs **OR** in locations indicated, **as directed**.
 - 2) Install control-joint strips back to back and directly above concrete-slab control joints **OR** in locations indicated, **as directed**.
 - 3) Install control-joint strips with **1/4-inch (6.4-mm)** gap between strips, and install sealant in gap.
 - 4) Install strips in adhesive setting bed without voids below strips, or mechanically anchor strips as required to attach strips to substrate, as recommended by strip manufacturer.
 - b. Expansion-Joint Strips (for structural portland cement terrazzo or for any type of rustic terrazzo): Form expansion joints using divider strips and install directly above concrete-slab expansion joints.

- c. Accessory Strips: Install accessory strips as required to provide a complete installation.
 - d. Abrasive Strips: Install with surface of abrasive strip positioned **1/16 inch (1.6 mm) OR 1/32 inch (0.8 mm), as directed**, higher than terrazzo surface.
- 7. Repair: Cut out and replace terrazzo areas that evidence lack of bond with substrate or underbed, including areas that emit a "hollow" sound if tapped. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA's written recommendations, as approved by the Owner.
- C. Portland Cement Terrazzo Installation
 - 1. Pour in place, cure, and finish portland cement terrazzo according to NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated.
 - 2. Terrazzo Topping Thickness: As indicated.
 - 3. Finishing:
 - a. Seed additional marble chips **OR** aggregates, **as directed**, in matrix to uniformly distribute granular material on surface.
 - b. Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted.
 - c. Fine Grinding: Grind with stones 120 grit or finer until all grout is removed from surface. Repeat rough grinding, grout coat, and fine grinding if large voids exist after initial fine grinding. Produce surface with a minimum of 70 percent aggregate exposure.
- D. Rustic Terrazzo Installation
 - 1. Pour in place, cure, and finish rustic terrazzo according to NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated.
 - 2. Terrazzo Topping Thickness: As indicated.
 - 3. Finishing:
 - a. Seed additional marble chips **OR** aggregates, **as directed**, in matrix to uniformly distribute granular material on surface.
- E. Precast Terrazzo Installation
 - 1. Install precast terrazzo units using method recommended by NTMA and manufacturer unless otherwise indicated.
 - 2. Installation Tolerance: Set units with alignment level and true to dimensions, varying **1/8 inch (3.2 mm)** maximum in length, height, or width; noncumulative.
 - 3. Do not install units that are chipped, cracked, discolored, or improperly finished.
 - 4. Seal joints between units with cement grout matching precast terrazzo matrix **OR** joint sealant, **as directed**.
- F. Cleaning And Protection
 - 1. Portland Cement Terrazzo and Precast Terrazzo Cleaning:
 - a. Remove grinding dust from installation and adjacent areas.
 - b. Wash surfaces with cleaner immediately after grouting precast terrazzo units and final cleaning of terrazzo flooring.
 - c. Wash surfaces with cleaner according to NTMA's written recommendations and manufacturer's written instructions; rinse surfaces with water and allow to dry thoroughly.
 - 2. Rustic Terrazzo Cleaning: Clean surfaces with 1:10 solution of muriatic acid in water. Legally contain and dispose of runoff from cleaning operations. Rinse surfaces with water and allow to dry thoroughly.
 - 3. Sealing:
 - a. Seal surfaces according to NTMA's written recommendations.
 - b. Apply sealer according to sealer manufacturer's written instructions.
 - 4. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that terrazzo is without damage or deterioration at time of Final Completion.

END OF SECTION 09 01 60 91

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Task	Specification	Specification Description
09 01 60 91	01 22 16 00	No Specification Required
09 01 60 91	07 92 13 00	Joint Sealants

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SECTION 09 51 13 00 - ACOUSTICAL PANEL CEILINGS

1.1 GENERAL

A. Description Of Work

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

B. Summary

1. This Section includes acoustical panels and exposed suspension systems for ceilings.
2. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

C. Definitions

1. AC: Articulation Class.
2. CAC: Ceiling Attenuation Class.
3. LR: Light Reflectance coefficient.
4. NRC: Noise Reduction Coefficient.

D. Submittals

1. Product Data: For each type of product indicated.
2. Coordination Drawings: Drawn to scale and coordinating acoustical panel ceiling installation with hanger attachment to building structure and ceiling mounted items:
3. Samples: For each exposed finish.
4. LEED Submittals:
 - a. Product Data for Credit MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - 1) Include statement indicating costs for each product having recycled content.
 - b. Product Data for Credit EQ 4.1: For sealants, including printed statement of VOC content.
5. Product test reports.
6. Research/evaluation reports.
7. Maintenance data.

E. Quality Assurance

1. Acoustical Testing Agency Qualifications: An independent testing laboratory, or an NVLAP-accredited laboratory, with the experience and capability to conduct the testing indicated. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.
2. Fire-Test-Response Characteristics
 - a. Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1) Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
 - 2) Identify materials with appropriate markings of applicable testing and inspecting agency.
 - b. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A **OR B OR C, as directed**, materials as determined by testing identical products per ASTM E 84:
 - 1) Smoke-Developed Index: 450 or less.

3. Seismic Standard: Provide acoustical panel ceilings designed and installed to withstand the effects of earthquake motions according to the following:
 - a. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.
 - b. Cisca's Recommendations for Acoustical Ceilings: Comply with Cisca's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings--Seismic Zones 0-2."
 - c. Cisca's Guidelines for Systems Requiring Seismic Restraint: Comply with Cisca's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies--Seismic Zones 3 & 4."
 - d. IBC Standard for Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings.
 - e. ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."
4. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling

1. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
2. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
3. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.2 PRODUCTS

A. Acoustical Panels, General

1. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.
 - a. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is **15-3/4 inches (400 mm)** away from test surface per ASTM E 795.
2. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
 - a. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by the Owner from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.
3. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.
4. Antimicrobial Fungicide Treatment: Provide acoustical panels with face and back surfaces coated with antimicrobial treatment consisting of manufacturer's standard formulation with fungicide added to inhibit growth of mold and mildew and showing no mold or mildew growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

B. Acoustical Panels For Acoustical Panel Ceiling

1. Classification: Provide fire-resistance-rated, **as directed**, panels complying with ASTM E 1264 for type, form, and pattern as follows:

- a. Type and Form: Type III, mineral base with painted finish; Form 1, nodular **OR** 2, water felted **OR** 4, cast or molded, **as directed**.
 - b. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 1, nodular; with glass-fiber cloth **OR** washable vinyl-film, **as directed**, overlay.
 - c. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 2, water felted; with vinyl overlay on face **OR** vinyl overlay on face and back **OR** vinyl overlay on face, back, and sealed edges **OR** fiberglass-fabric overlay on face, **as directed**.
 - d. Type and Form: Type XII, glass-fiber base with membrane-faced overlay; Form 1, plastic **OR** 2, cloth **OR** 3, other, **as directed**.
 - e. Type and Form: Type XX, other types; described as high-density, ceramic- and mineral-base panels with scrubbable finish, resistant to heat, moisture, and corrosive fumes.
 - f. Pattern: C (perforated, small holes) **OR** CD (perforated, small holes and fissured) **OR** CE (perforated, small holes and lightly textured) **OR** D (fissured) **OR** E (lightly textured) **OR** F (heavily textured) **OR** G (smooth) **OR** GH (smooth and printed) **OR** I (embossed) **OR** J (embossed-in-register) **OR** K (surface scored) **OR** Z (other patterns as described) **OR** As indicated by manufacturer's designation, **as directed**.
 2. Color: White **OR** As selected from manufacturer's full range **OR** Match sample **OR** As indicated by manufacturer's designation **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
 3. LR: Not less than 0.65 **OR** 0.70 **OR** 0.75 **OR** 0.80 **OR** 0.85 **OR** 0.90, **as directed**.
 4. NRC: Not less than 0.10 **OR** 0.35 **OR** 0.40 **OR** 0.50 **OR** 0.55 **OR** 0.60 **OR** 0.65 **OR** 0.70 **OR** 0.75 **OR** 0.80 **OR** 0.85 **OR** 0.90 **OR** 0.95 **OR** 1.00, **as directed**.
 5. CAC: Not less than 20 **OR** 25 **OR** 30 **OR** 35 **OR** 40, **as directed**.
 6. AC: Not less than 170 **OR** 180 **OR** 190 **OR** 200 **OR** 210, **as directed**.
 7. Edge/Joint Detail: Square **OR** Reveal sized to fit flange of exposed suspension system members **OR** Flush reveal sized to fit flange of exposed suspension system members **OR** Beveled, kerfed and rabbeted long edges and square, butt-on short edges, **as directed**.
 8. Thickness: 5/8 inch (15 mm) **OR** 3/4 inch (19 mm) **OR** 7/8 inch (22 mm) **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
 9. Thickness (For glass-fiber-based panels): 1/8 inch (3 mm) **OR** 9/16 inch (15 mm) **OR** 5/8 inch (15 mm) **OR** 7/16 inch (22 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm) **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
 10. Modular Size: 24 by 24 inches (610 by 610 mm) **OR** 24 by 48 inches (610 by 1220 mm) **OR** 600 by 600 mm **OR** 600 by 1200 mm **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
 11. Antimicrobial Treatment: Broad spectrum fungicide and bactericide **OR** Fungicide, **as directed**, based.
- C. Metal Suspension Systems, General
1. Recycled Content: Provide products made from steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
 2. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
 3. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
 - a. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.
 4. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
 - a. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per

ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.

- 1) Type: Cast-in-place **OR** Postinstalled expansion **OR** Postinstalled bonded, **as directed**, anchors.
 - 2) Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
 - 3) Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.
 - 4) Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.
 - b. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.
5. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
- a. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
OR
Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
OR
Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.
 - b. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than **0.106-inch- (2.69-mm-)** **OR** **0.135-inch- (3.5-mm-)**, **as directed**, diameter wire.
6. Hanger Rods **OR** Flat Hangers, **as directed**: Mild steel, zinc coated or protected with rust-inhibitive paint.
7. Angle Hangers: Angles with legs not less than **7/8 inch (22 mm)** wide; formed with **0.04-inch- (1-mm-)** thick, galvanized steel sheet complying with ASTM A 653/A 653M, **G90 (Z275)** coating designation; with bolted connections and **5/16-inch- (8-mm-)** diameter bolts.
8. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
9. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
10. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in-place.
11. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced **24 inches (610 mm)** o.c. on all cross tees.
12. Impact Clips: Where indicated, provide manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.
13. Clean-Room Gasket System: Where indicated, provide manufacturer's standard system, including manufacturer's standard **OR** closed-cell PVC **OR** neoprene **OR** antimicrobial, **as directed**, gasket and related adhesives, tapes, seals, and retention clips, designed to seal out foreign material from and maintain positive pressure in clean room.
- D. Metal Suspension System For Acoustical Panel Ceiling
1. Wide-Face, Capped, Double-Web, Fire-Rated, **as directed**, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than **G30 (Z90)** coating designation, with prefinished **15/16-inch- (24-mm-)** wide metal caps on flanges.
 - a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
 - b. End Condition of Cross Runners: Override (stepped) **OR** Butt-edge, **as directed**, type.
 - c. Face Design: Flat, flush.
 - d. Cap Material: Steel **OR** Aluminum, **as directed**, cold-rolled sheet.
 - e. Cap Finish: Painted white **OR** Painted in color as selected from manufacturer's full range **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match

- color of acoustical unit **OR** Plated with metallic finish, as selected from manufacturer's full range **OR** Plated with metallic finish indicated by manufacturer's designation **OR** Natural finish for aluminum, **as directed**.
2. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than **G30 (Z90)** coating designation, with prefinished **9/16-inch- (15-mm-)** wide metal caps on flanges.
 - a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
 - b. End Condition of Cross Runners: Override (stepped) **OR** Butt-edge, **as directed**, type.
 - c. Face Design: Flat, flush **OR** Flanges formed with an integral center reveal, **as directed**.
 - d. Cap Material: Steel **OR** Aluminum, **as directed**, cold-rolled sheet.
 - e. Cap Finish: Painted white **OR** Painted in color as selected from manufacturer's full range **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match color of acoustical unit **OR** Plated with metallic finish, as selected from manufacturer's full range **OR** Plated with metallic finish indicated by manufacturer's designation **OR** Natural finish for aluminum, **as directed**.
 3. Narrow-Face, Steel-Capped, Double-Web, Fire-Rated Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than **G30 (Z90)** coating designation, with prefinished, cold-rolled, **9/16-inch- (15-mm-)** wide metal caps on flanges.
 - a. Structural Classification: Intermediate-duty system.
 - b. Face Design: Flat, flush.
 - c. Cap Finish: Painted white **OR** Painted in color as selected from manufacturer's full range **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match color of acoustical unit **OR** Plated with metallic finish, as selected from manufacturer's full range **OR** Plated with metallic finish indicated by manufacturer's designation **OR** Natural finish for aluminum, **as directed**.
 4. Narrow-Face, Uncapped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized, to produce structural members with **9/16-inch- (15-mm-)** wide faces.
 - a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
 - b. Face Design: With **1/8-inch- (3.2-mm-)** wide, slotted, box-shaped flange **OR** With **1/4-inch- (6.35-mm-)** wide, slotted, box-shaped flange **OR** Flanges formed in stepped design with a center protrusion projecting **19/64 inch (7.54 mm)** below flange surfaces supporting panel faces and forming **3/16-inch- (4.76-mm-)** wide reveals between edges of protrusion and those of panels, **as directed**.
 - c. Face Finish: Painted white **OR** in color as selected from manufacturer's full range **OR** to match color indicated by manufacturer's designation **OR** to match color of acoustical unit, **as directed**.
 - d. Reveal Finish: Painted to match flange color **OR** white **OR** black **OR** in color other than flange color as selected from manufacturer's full range of contrasting reveal colors, **as directed**.
 5. Wide-Face, Capped, Double-Web, Fire-Rated, **as directed**, Hot-Dip Galvanized, **G60 (Z180)**, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, hot-dip galvanized according to ASTM A 653/A 653M, **G60 (Z180)** coating designation, with prefinished, cold-rolled, **15/16-inch- (24-mm-)** wide, aluminum caps on flanges.
 - a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
 - b. Face Design: Flat, flush.
 - c. Face Finish: Painted white **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match color of acoustical unit **OR** Natural finish, **as directed**.
 6. Wide-Face, Single-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet electrolytically zinc coated, with prefinished flanges of width indicated.
 - a. Structural Classification: Heavy-duty system.
 - b. Face Finish: Painted white **OR** black, **as directed**.

7. Wide-Face, Capped, Double-Web, Stainless-Steel Suspension System: Main and cross runners roll formed from Type 304 or 316, stainless-steel sheet, with prefinished **15/16-inch- (24-mm-)** wide, stainless-steel caps on flanges.
 - a. Structural Classification: Intermediate-duty system.
 - b. Face Design: Flat, flush.
8. Narrow-Face, Single-Web, Extruded-Aluminum Suspension System: Main and cross runners formed from extruded aluminum to produce structural members with **9/16-inch- (15-mm-)** wide faces.
 - a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
 - b. Face Design: Screw-slot profile.
 - c. Face Finish: Painted white **OR** Satin anodized per AA-M12C22A31 and AAMA 611, **as directed**.
 - d. Reveal Finish: Match face finish **OR** Painted white **OR** Painted black, **as directed**.
9. Extra-Wide-Face, Double-Web **OR** Single-Web, **as directed**, Metal Suspension System: Main and cross runners formed from extruded aluminum **OR** aluminum-capped steel **OR** steel-capped steel, **as directed**, to produce structural members with **1-1/2-inch- (50-mm-)** **OR** **2-inch- (50-mm-)**, **as directed**, wide flanges.
 - a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
 - b. Face Design: Flat, flush.
 - c. Face Finish: Painted white **OR** Satin anodized per AA-M12C22A31 and AAMA 611, **as directed**.
 - d. Gasket System: Clean-room type.

E. Metal Edge Moldings And Trim

1. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
 - a. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.
 - b. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
 - c. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
2. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
 - a. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with **ASTM B 221 (ASTM B 221M)** for Alloy and Temper 6063-T5.
 - b. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.
 - c. Conversion-Coated Finish: AA-M12C42 (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating).
 - d. Conversion-Coated and Factory-Primed Finish: AA-M12C42R1x (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating; organic coating as follows):
 - 1) Manufacturer's standard, factory-applied prime-coat finish ready for field painting.
 - e. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

- f. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; organic coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
 - 1) Organic Coating: Thermosetting, primer/topcoat system with a minimum dry film thickness of **0.8 to 1.2 mils** (0.02 to 0.03 mm).

F. Acoustical Sealant

- 1. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
- 2. Acoustical Sealant for Concealed Joints: Manufacturer's standard nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), recommended for sealing interior concealed joints to reduce airborne sound transmission.

1.3 EXECUTION

A. Preparation

- 1. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

B. Installation

- 1. General: Install acoustical panel ceilings to comply with ASTM C 636 **OR** IBC Standard, **as directed**, and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
 - a. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.
- 2. Suspend ceiling hangers from building's structural members and as follows:
 - a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - b. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - c. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - d. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - e. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - f. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 - g. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.

- h. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
- i. Do not attach hangers to steel deck tabs.
- j. Do not attach hangers to steel roof deck. Attach hangers to structural members.
- k. Space hangers not more than **48 inches (1200 mm)** o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than **8 inches (200 mm)** from ends of each member.
- l. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- 3. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- 4. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
 - a. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 - b. Screw attach moldings to substrate at intervals not more than **16 inches (400 mm)** o.c. and not more than **3 inches (75 mm)** from ends, leveling with ceiling suspension system to a tolerance of **1/8 inch in 12 feet (3.2 mm in 3.6 m)**. Miter corners accurately and connect securely.
 - c. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- 5. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- 6. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
 - a. Arrange directionally patterned acoustical panels as follows:
 - 1) As indicated on reflected ceiling plans.
OR
 Install panels with pattern running in one direction parallel to long **OR** short, **as directed**, axis of space.
OR
 Install panels in a basket-weave pattern.
 - b. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
 - c. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 - d. For reveal-edged panels on suspension system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension system surfaces and panel faces flush with bottom face of runners.
 - e. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
 - f. Install hold-down clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions, unless otherwise indicated.
 - g. Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.
 - h. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

C. Field Quality Control

- 1. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

2. Tests and Inspections: Testing and inspecting of completed installations of acoustical panel ceiling hangers and anchors and fasteners shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.
 - a. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed.
 - 1) Within each test area, testing agency will select 1 of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select one of every 2 postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
 - 2) When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
3. Remove and replace acoustical panel ceiling hangers and anchors and fasteners that do not pass tests and inspections and retest as specified above.

D. Cleaning

1. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 13 00

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Task	Specification	Specification Description
09 53 23 00	09 51 13 00	Acoustical Panel Ceilings

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SECTION 09 65 13 13 - 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 marks, 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 09 65 13 13

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SECTION 09 65 13 13a - RESILIENT WALL BASE AND ACCESSORIES

1.1 GENERAL

- A. Description Of Work
 - 1. This specification covers the furnishing and installation of materials for resilient wall base and accessories. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.
- B. Summary
 - 1. Section Includes:
 - a. Resilient base.
 - b. Resilient stair accessories.
 - c. Resilient molding accessories.
- C. Submittals
 - 1. Product Data: For each type of product indicated.
 - 2. LEED Submittals:
 - a. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
 - 3. Samples: For each type of product indicated, in manufacturer's standard-size Samples but not less than **12 inches (300 mm)** long, of each resilient product color, texture, and pattern required.
- D. Quality Assurance
 - 1. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - a. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- E. Delivery, Storage, And Handling
 - 1. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than **50 deg F (10 deg C)** or more than **90 deg F (32 deg C)**.
- F. Project Conditions
 - 1. Maintain ambient temperatures within range recommended by manufacturer, but not less than **70 deg F (21 deg C)** or more than **95 deg F (35 deg C)**, in spaces to receive resilient products during the following time periods:
 - a. 48 hours before installation.
 - b. During installation.
 - c. 48 hours after installation.
 - 2. Until Final Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than **55 deg F (13 deg C)** or more than **95 deg F (35 deg C)**.
 - 3. Install resilient products after other finishing operations, including painting, have been completed.

1.2 PRODUCTS

- A. Resilient Base
 - 1. Resilient Base Standard: ASTM F 1861.
 - a. Material Requirement: Type TV (vinyl, thermoplastic) **OR** Type TS (rubber, vulcanized thermoset) **OR** Type TP (rubber, thermoplastic), **as directed**.
 - b. Manufacturing Method: Group I (solid, homogeneous) **OR** Group II (layered), **as directed**.

- c. Style: Cove (base with toe) **OR** Straight (flat or toeless) **OR** Butt to (fit-to-floor), **as directed**.
 2. Minimum Thickness: **0.125 inch (3.2 mm) OR 0.080 inch (2.0 mm), as directed.**
 3. Height: **2-1/2 inches (64 mm) OR 4 inches (102 mm) OR 6 inches (152 mm) OR** As indicated on Drawings, **as directed.**
 4. Lengths: Cut lengths, **48 inches (1219 mm) long OR** Coils in manufacturer's standard length, **as directed.**
 5. Outside Corners: Job formed **OR** Preformed, **as directed.**
 6. Inside Corners: Job formed **OR** Preformed, **as directed.**
 7. Finish: Satin **OR** Matte **OR** Low luster **OR** As selected from manufacturer's full range, **as directed.**
 8. Colors and Patterns: As selected from full range of industry colors.
- B. Resilient Stair Accessories**
1. Resilient Stair Treads Standard: ASTM F 2169.
 - a. Material Requirement: Type TV (vinyl, thermoplastic) **OR** Type TS (rubber, vulcanized thermoset) **OR** Type TP (rubber, thermoplastic), **as directed.**
 - b. Surface Design:
 - 1) Class 1, Smooth (flat).
 - 2) Class 2, Pattern: Raised-disc design **OR** Raised-square design **OR** Raised-chevron design **OR** Raised-diamond design **OR** Raised-rib design **OR** Raised-rib design with abrasive strips, **as directed.**
 - c. Manufacturing Method: Group 1, tread with embedded abrasive strips **OR** Group 2, tread with contrasting color for the visually impaired, **as directed.**
 2. Nosing Style: Square, adjustable to cover angles between 60 and 90 degrees **OR** Square **OR** Round, **as directed.**
 3. Nosing Height: **1-1/2 inches (38 mm) OR 2 inches (51 mm) OR 2-3/16 inches (56 mm), as directed.**
 4. Thickness: **1/4 inch (6 mm)** and tapered to back edge.
 5. Size: Lengths and depths to fit each stair tread in one piece **OR** one piece or, for treads exceeding maximum lengths manufactured, in equal-length units, **as directed.**
 6. Risers: Smooth, flat, coved-toe, **7 inches (178 mm)** high by length matching treads **OR** toeless, height and length to cover risers, **as directed**; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.
 - a. Thickness: **0.125 inch (3.2 mm) OR 0.080 inch (2.0 mm), as directed.**
 7. Stringers: Of same thickness as risers, height and length after cutting to fit risers and treads and to cover stair stringers; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.
 8. Colors and Patterns: As selected from full range of industry colors.
- C. Resilient Molding Accessory**
1. Description: Cap for cove carpet **OR** Cap for cove resilient floor covering **OR** Carpet bar for tackless installations **OR** Carpet edge for glue-down applications **OR** Nosing for carpet **OR** Nosing for resilient floor covering **OR** Reducer strip for resilient floor covering **OR** Joiner for tile and carpet **OR** Transition strips, **as directed.**
 2. Material: Vinyl **OR** Rubber, **as directed.**
 3. Profile and Dimensions: As indicated.
 4. Colors and Patterns: As selected from full range of industry colors.
- D. Installation Materials**
1. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
 2. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

- a. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1) Cove Base Adhesives: Not more than 50 g/L.
 - 2) Rubber Floor Adhesives: Not more than 60 g/L.
3. Stair-Tread-Nose Filler: Two-part epoxy compound recommended by resilient tread manufacturer to fill nosing substrates that do not conform to tread contours.
4. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edges of tiles, and in maximum available lengths to minimize running joints.
5. Floor Polish: Provide protective liquid floor polish products as recommended by resilient stair tread manufacturer.

1.3 EXECUTION

A. Preparation

1. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
2. Concrete Substrates for Resilient Stair Treads and Accessories: Prepare according to ASTM F 710.
 - a. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - b. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 - c. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer.
 - d. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
 - 1) Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of **3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m)** in 24 hours.
 - 2) Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.
3. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
4. Do not install resilient products until they are same temperature as the space where they are to be installed.
 - a. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
5. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

B. Resilient Base Installation

1. Comply with manufacturer's written instructions for installing resilient base.
2. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
3. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
4. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
5. Do not stretch resilient base during installation.
6. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
7. Preformed Corners: Install preformed corners before installing straight pieces.
8. Job-Formed Corners:
 - a. Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends.

b. Inside Corners: Use straight pieces of maximum lengths possible.

C. Resilient Accessory Installation

1. Comply with manufacturer's written instructions for installing resilient accessories.
2. Resilient Stair Accessories:
 - a. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
 - b. Tightly adhere to substrates throughout length of each piece.
 - c. For treads installed as separate, equal-length units, install to produce a flush joint between units.
3. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of carpet **OR** resilient floor covering, **as directed**, that would otherwise be exposed.

D. Cleaning And Protection

1. Comply with manufacturer's written instructions for cleaning and protection of resilient products.
2. Perform the following operations immediately after completing resilient product installation:
 - a. Remove adhesive and other blemishes from exposed surfaces.
 - b. Sweep and vacuum surfaces thoroughly.
 - c. Damp-mop surfaces to remove marks and soil.
3. Protect resilient products from marks, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
4. Floor Polish: Remove soil, visible adhesive, and surface blemishes from resilient stair treads before applying liquid floor polish.
 - a. Apply one **OR** two **OR** three, **as directed**, coat(s).
5. Cover resilient products until Final Completion.

END OF SECTION 09 65 13 13a

SECTION 09 68 13 00 - CARPET TILE

1.1 GENERAL

A. Description Of Work

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

B. Summary

1. This Section includes modular, fusion-bonded **OR** tufted, **as directed**, carpet tile.

C. Submittals

1. Product Data: For each product indicated.
2. Shop Drawings: Show the following:
 - a. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
 - b. Existing flooring materials to be removed.
 - c. Existing flooring materials to remain.
 - d. Carpet tile type, color, and dye lot.
 - e. Type of subfloor.
 - f. Type of installation.
 - g. Pattern of installation.
 - h. Pattern type, location, and direction.
 - i. Pile direction.
 - j. Type, color, and location of insets and borders.
 - k. Type, color, and location of edge, transition, and other accessory strips.
 - l. Transition details to other flooring materials.
3. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - a. Carpet Tile: Full-size Sample.
 - b. Exposed Edge, Transition, and other Accessory Stripping: **12-inch-** (300-mm-) long Samples.
4. LEED Submittal:
 - a. Product Data for Credit EQ 4.3:
 - 1) For carpet tile, documentation indicating compliance with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.
 - 2) For installation adhesive, including printed statement of VOC content.
5. Product Schedule: For carpet tile. Use same designations indicated on Drawings.
6. Maintenance data.

D. Quality Assurance

1. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.
2. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling

1. Comply with CRI 104, Section 5, "Storage and Handling."

F. Project Conditions

1. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
2. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
3. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
4. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

G. Warranty

1. Special Warranty for Carpet Tiles: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - a. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
 - b. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, dimensional stability, excess static discharge, and delamination.
 - c. Warranty Period: 10 years from date of Final Completion.

1.2 PRODUCTS

A. Carpet Tile

1. Fiber Content: 100 percent nylon 6, 6 **OR** 100 percent nylon 6 **OR** 100 percent polypropylene **OR** 100 percent wool **OR** 80 percent wool; 20 percent nylon 6, 6 **OR** 80 percent wool; 20 percent nylon 6, **as directed**.
2. Fiber Type: **<Insert proprietary fiber type.>**
3. Pile Characteristic: Level-loop **OR** Cut **OR** Cut-and-loop, **as directed**, pile.
4. Yarn Twist: **<Insert twist in TPI (TPCM).>**
5. Yarn Count: **<Insert yarn count.>**
6. Density: **<Insert oz./cu. yd. (g/cu. cm).>**
7. Pile Thickness: **<Insert inches (mm)>** for finished carpet tile per ASTM D 6859.
8. Stitches: **<Insert stitches per inch (mm).>**
9. Gage: **<Insert gage in ends per inch (mm).>**
10. Surface Pile Weight: **<Insert oz./sq. yd. (g/sq. m).>**
11. Total Weight: **<Insert oz./sq. yd. (g/sq. m)>** for finished carpet tile.
12. Primary Backing/Backcoating: Manufacturer's standard composite materials **OR** PVC **OR** Fiberglass-reinforced PVC **OR** Fiberglass-reinforced amorphous resin **OR** Reinforced polyurethane composite cushion **OR** Reinforced polyurethane composite **OR** Reinforced thermoplastic copolymer, **as directed**.
13. Secondary Backing: Manufacturer's standard material.
14. Backing System: **<Insert proprietary name.>**
15. Size: **18 by 18 inches (457 by 457 mm) OR 24 by 24 inches (610 by 610 mm) OR 18 by 36 inches (457 by 914 mm) OR 36 by 36 inches (914 by 914 mm), as directed.**
16. Applied Soil-Resistance Treatment: Manufacturer's standard material.
17. Antimicrobial Treatment: Manufacturer's standard material.
18. Performance Characteristics: As follows:
 - a. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**.
 - b. Dry Breaking Strength: Not less than **100 lbf (445 N)** per ASTM D 2646.
 - c. Tuft Bind: Not less than **3 lbf (13 N) OR 5 lbf (22 N) OR 6.2 lbf (28 N) OR 8 lbf (36 N) OR 10 lbf (45 N), as directed**, per ASTM D 1335.

- d. Delamination: Not less than **3.5 lbf/in. (15 N/mm)** **OR 4 lbf/in. (18 N/mm)**, **as directed**, per ASTM D 3936.
- e. Dimensional Tolerance: Within **1/32 inch (0.8 mm)** of specified size dimensions, as determined by physical measurement.
- f. Dimensional Stability: 0.2 percent or less per ISO 2551 (Aachen Test).
- g. Resistance to Insects: Comply with AATCC 24.
- h. Noise Reduction Coefficient (NRC): **<Insert NRC>** per ASTM C 423.
- i. Colorfastness to Crocking: Not less than 4, wet and dry, per AATCC 165.
- j. Colorfastness to Light: Not less than 4 after 40 **OR 60**, **as directed**, AFU (AATCC fading units) per AATCC 16, Option E.
- k. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria; not less than 1-mm halo of inhibition for gram-negative bacteria; no fungal growth; per AATCC 174.
- l. Electrostatic Propensity: Less than 3.5 **OR 2**, **as directed**, kV per AATCC 134.
- m. Environmental Requirements: Provide carpet tile that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.

B. Installation Accessories

- 1. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- 2. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
 - a. VOC Limits: Provide adhesives with VOC content not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24).

1.3 EXECUTION

A. Preparation

- 1. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
- 2. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions **1/8 inch (3 mm)** wide or wider and protrusions more than **1/32 inch (0.8 mm)**, unless more stringent requirements are required by manufacturer's written instructions.
- 3. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.
- 4. Clean metal substrates of grease, oil, soil and rust, and prime if directed by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.
- 5. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

B. Installation

- 1. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
- 2. Installation Method: As recommended in writing by carpet tile manufacturer **OR** Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive **OR** Partial glue down; install periodic tiles with releasable, pressure-sensitive adhesive **OR** Free lay; install carpet tiles without adhesive, **as directed**.
- 3. Maintain dye lot integrity. Do not mix dye lots in same area.
- 4. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

5. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
6. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
7. Install pattern parallel to walls and borders.
8. Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

C. Cleaning And Protection

1. Perform the following operations immediately after installing carpet tile:
 - a. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - b. Remove yarns that protrude from carpet tile surface.
 - c. Vacuum carpet tile using commercial machine with face-beater element.
2. Protect installed carpet tile to comply with CRI 104, Section 16, "Protection of Indoor Installations."
3. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09 68 13 00

SECTION 09 68 16 00 - CARPET

1.1 GENERAL

A. Description Of Work

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

B. Summary

1. This Section includes the following:
 - a. Tufted carpet.
 - b. Woven carpet.
 - c. Carpet cushion.

C. Submittals

1. Product Data: For each product indicated.
2. Shop Drawings: Show the following:
 - a. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet.
 - b. Existing flooring materials to be removed.
 - c. Existing flooring materials to remain.
 - d. Carpet type, color, and dye lot.
 - e. Locations where dye lot changes occur.
 - f. Seam locations, types, and methods.
 - g. Type of subfloor.
 - h. Type of installation.
 - i. Pattern type, repeat size, location, direction, and starting point.
 - j. Pile direction.
 - k. Type, color, and location of insets and borders.
 - l. Type, color, and location of edge, transition, and other accessory strips.
 - m. Transition details to other flooring materials.
 - n. Type of carpet cushion.
3. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - a. Carpet: 12-inch- (300-mm-) square Sample.
 - b. Exposed Edge, Transition, and other Accessory Stripping: 12-inch- (300-mm-) long Samples.
 - c. Carpet Cushion: 6-inch- (150-mm-) square Sample.
 - d. Carpet Seam: 6-inch (150-mm) Sample.
 - e. Mitered Carpet Border Seam: 12-inch- (300-mm-) square Sample. Show carpet pattern alignment.
4. LEED Submittals:
 - a. Product Data for Credit EQ 4.3:
 - 1) For carpet, documentation indicating compliance with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.
 - 2) For carpet cushion, documentation indicating compliance with testing and product requirements of Carpet and Rug Institute's "Green Label" program.
 - 3) For installation adhesive, including printed statement of VOC content.
5. Product Schedule: For carpet and carpet cushion. Use same designations indicated on Drawings.
6. Maintenance data.

- D. Quality Assurance
1. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.
 2. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 1.2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
 3. Preinstallation Conference: Conduct conference at Project site.
- E. Delivery, Storage, And Handling
1. Comply with CRI 104, Section 5, "Storage and Handling."
- F. Project Conditions
1. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
 2. Environmental Limitations: Do not install carpet and carpet cushion until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 3. Do not install carpet and carpet cushion over concrete slabs until slabs have cured, are sufficiently dry to bond with adhesive, and have pH range recommended by carpet manufacturer.
 4. Where demountable partitions or other items are indicated for installation on top of carpet, install carpet before installing these items.
- G. Warranty
1. Special Warranty for Carpet: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.
 - a. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
 - b. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, excess static discharge, and delamination.
 - c. Warranty Period: 10 years from date of Final Completion.
 2. Special Warranty for Carpet Cushion: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet cushion installation that fail in materials or workmanship within specified warranty period.
 - a. Warranty includes consequent removal and replacement of carpet and accessories.
 - b. Warranty does not include deterioration or failure of carpet cushion due to unusual traffic, failure of substrate, vandalism, or abuse.
 - c. Failure includes, but is not limited to, permanent indentation or compression.
 - d. Warranty Period: 10 years from date of Final Completion.

1.2 PRODUCTS

- A. Tufted Carpet
1. Fiber Content: 100 percent nylon 6, 6 **OR** 100 percent nylon 6 **OR** 100 percent polypropylene, **as directed**.
 2. Pile Characteristic: Level-loop **OR** Cut **OR** Cut-and-loop **OR** Multilevel-loop **OR** Level tip shear **OR** Random shear **OR** Frieze **OR** Sculptured, **as directed**, pile.
 3. Yarn Twist: as directed by the Owner.
 4. Yarn Count: as directed by the Owner.
 5. Density: as directed by the Owner.
 6. Pile Thickness: finished carpet per ASTM D 6859.
 7. Stitches: as directed by the Owner.
 8. Gage: as directed by the Owner.
 9. Face Weight: as directed by the Owner.

10. Total Weight: for finished carpet.
11. Primary Backing: Manufacturer's standard material **OR** Woven polypropylene **OR** Nonwoven, polypropylene or polyester, **as directed**.
12. Secondary Backing: Manufacturer's standard material **OR** Woven polypropylene **OR** Nonwoven, polypropylene or polyester **OR** Woven jute **OR** Fiberglass, **as directed**.
13. Backcoating: Manufacturer's standard material **OR** SBR latex **OR** PVC **OR** Thermoplastic copolymer, **as directed**.
14. Width: **12 feet (3.7 m) OR 6 feet (1.8 m) OR 13.5 feet (4.1 m) OR 15 feet (4.6 m), as directed.**
15. Applied Soil-Resistance Treatment: Manufacturer's standard material.
16. Antimicrobial Treatment: Manufacturer's standard material.
17. Performance Characteristics: As follows:
 - a. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**.
 - b. Dry Breaking Strength: Not less than **100 lbf (445 N)** per ASTM D 2646.
 - c. Tuft Bind: Not less than **3 lbf (13 N) OR 5 lbf (22 N) OR 6.2 lbf (28 N) OR 8 lbf (36 N) OR 10 lbf (45 N), as directed**, per ASTM D 1335.
 - d. Delamination: Not less than **2.5 lbf/in. (12 N/mm) OR 3.5 lbf/in. (15 N/mm) OR 4 lbf/in. (18 N/mm), as directed**, per ASTM D 3936.
 - e. Resistance to Insects: Comply with AATCC 24.
 - f. Noise Reduction Coefficient (NRC): per ASTM C 423.
 - g. Colorfastness to Crocking: Not less than 4, wet and dry, per AATCC 165.
 - h. Colorfastness to Light: Not less than 4 after 40 **OR** 60, **as directed**, AFU (AATCC fading units) per AATCC 16, Option E.
 - i. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria; not less than 1-mm halo of inhibition for gram-negative bacteria; no fungal growth; per AATCC 174.
 - j. Electrostatic Propensity: Less than 3.5 **OR** 2, **as directed**, kV per AATCC 134.
 - k. Environmental Requirements: Provide carpet that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.

B. Woven Carpet

1. Fiber Content: 100 percent wool **OR** 80 percent wool; 20 percent nylon 6, 6 **OR** 80 percent wool; 20 percent nylon 6, **as directed**.
2. Face Construction: Axminster **OR** Wilton **OR** Velvet, **as directed**.
3. Pile Characteristic: Level-loop **OR** Cut **OR** Cut-and-loop, **as directed**, pile.
4. Yarn Twist: as directed by the Owner.
5. Yarn Count: as directed by the Owner.
6. Density: as directed by the Owner.
7. Pile Thickness: for finished carpet per ASTM D 6859.
8. Rows: as directed by the Owner.
9. Pitch: as directed by the Owner.
10. Face Weight: as directed by the Owner.
11. Total Weight: as directed by the Owner., for finished carpet.
12. Backing: Manufacturers standard **OR** As follows, **as directed**:
 - a. Chain Warp: as directed by the Owner.
 - b. Stuffer Warp: as directed by the Owner.
 - c. Shot or Fill Weft: as directed by the Owner.
 - d. Backcoating: as directed by the Owner.
13. Applied Soil-Resistance Treatment: Manufacturer's standard material.
14. Performance Characteristics: As follows:
 - a. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**.
 - b. Dry Breaking Strength: Not less than **100 lbf (445 N)** per ASTM D 2646.
 - c. Resistance to Insects: Comply with AATCC 24.
 - d. Noise Reduction Coefficient (NRC): per ASTM C 423.
 - e. Colorfastness to Crocking: Not less than 4, wet and dry, per AATCC 165.

- f. Colorfastness to Light: Not less than 4 after 40 **OR** 60, **as directed**, AFU (AATCC fading units) per AATCC 16, Option E.
- g. Electrostatic Propensity: Less than 3.5 **OR** 2, **as directed**, kV per AATCC 134.
- h. Environmental Requirements: Provide carpet that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.

C. Carpet Cushion

- 1. Traffic Classification: CCC Class I, moderate **OR** II, heavy **OR** III, extra-heavy, **as directed**, traffic.
- 2. Fiber Cushion: Rubberized hair, mothproofed and sterilized **OR** Rubberized jute, mothproofed and sterilized **OR** Synthetic **OR** Resinated, recycled textile, **as directed**.
 - a. Weight: as directed by the Owner.
 - b. Thickness: as directed by the Owner.plus 5 percent maximum.
 - c. Density: as directed by the Owner.
- 3. Rubber Cushion: Flat **OR** Rippled waffle **OR** Textured flat **OR** Reinforced, **as directed**.
 - a. Weight: as directed by the Owner.
 - b. Thickness: as directed by the Owner.plus 5 percent maximum.
 - c. Compression Resistance: at 25 **OR** 65, **as directed**, percent per ASTM D 3676.
 - d. Density: as directed by the Owner.
- 4. Polyurethane-Foam Cushion: Grafted prime **OR** Densified **OR** Bonded **OR** Mechanically frothed, **as directed**.
 - a. Compression Force Deflection at 65 Percent: per ASTM D 3574.
 - b. Thickness: as directed by the Owner.
 - c. Density: as directed by the Owner.
- 5. Performance Characteristics: As follows:
 - a. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**.
 - b. Noise Reduction Coefficient (NRC): per ASTM C 423.
 - c. Environmental Requirements: Provide carpet cushion that complies with testing and product requirements of Carpet and Rug Institute's "Green Label" program.

D. Installation Accessories

- 1. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet **OR** carpet cushion, **as directed**, manufacturer.
- 2. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended or provided by carpet manufacturer **OR** carpet and carpet cushion manufacturers, **as directed**.
 - a. VOC Limits: Provide adhesives with VOC content not more than 50g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24).
- 3. Tackless Carpet Stripping: Water-resistant plywood, in strips as required to match cushion thickness and that comply with CRI 104, Section 12.2.
- 4. Seam Adhesive: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.
- 5. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

1.3 EXECUTION

A. Preparation

- 1. General: Comply with CRI 104, Section 7.3, "Site Conditions; Floor Preparation," and with carpet manufacturer's written installation instructions for preparing substrates.

2. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions **1/8 inch (3 mm)** wide or wider, and protrusions more than **1/32 inch (0.8 mm)**, unless more stringent requirements are required by manufacturer's written instructions.
3. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet **OR** carpet cushion, **as directed**, manufacturer.
4. Broom and vacuum clean substrates to be covered immediately before installing carpet.

B. Installation

1. Comply with CRI 104 and carpet manufacturer's **OR** carpet and carpet cushion manufacturers', **as directed**, written installation instructions for the following:
 - a. Direct-Glue-Down Installation: Comply with CRI 104, Section 9, "Direct Glue-Down Installation."
 - b. Double-Glue-Down Installation: Comply with CRI 104, Section 10, "Double Glue-Down Installation."
 - c. Carpet with Attached-Cushion Installation: Comply with CRI 104, Section 11, "Attached-Cushion Installations."
 - d. Preapplied Adhesive Installation: Comply with CRI 104, Section 11.4, "Pre-Applied Adhesive Systems (Peel and Stick)."
 - e. Hook-and-Loop Installation: Comply with CRI 104, Section 11.5, "Hook and Loop Technology."
 - f. Stretch-in Installation: Comply with CRI 104, Section 12, "Stretch-in Installation."
 - g. Stair Installation: Comply with CRI 104, Section 13, "Carpet on Stairs" for stretch-in **OR** glue-down, **as directed**, installation.
2. Comply with carpet manufacturer's written recommendations and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.
 - a. Bevel adjoining border edges at seams with hand shears **OR** Level adjoining border edges, **as directed**.
3. Do not bridge building expansion joints with carpet.
4. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.
5. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
6. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
7. Install pattern parallel to walls and borders to comply with CRI 104, Section 15, "Patterned Carpet Installations" and with carpet manufacturer's written recommendations.
8. Comply with carpet cushion manufacturer's written recommendations. Install carpet cushion seams at 90-degree angle with carpet seams.

C. Cleaning And Protecting

1. Perform the following operations immediately after installing carpet:
 - a. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
 - b. Remove yarns that protrude from carpet surface.
 - c. Vacuum carpet using commercial machine with face-beater element.
2. Protect installed carpet to comply with CRI 104, Section 16, "Protection of Indoor Installations."
3. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet manufacturer and carpet cushion manufacturer **OR** and carpet adhesive manufacturer **OR** and carpet cushion and adhesive manufacturers, **as directed**.

END OF SECTION 09 68 16 00

Task	Specification	Specification Description
09 68 16 00	09 68 13 00	Carpet Tile

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SECTION 09 84 13 00 - 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 C 1177/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 09 84 13 00

SECTION 09 84 13 00a - GYPSUM BOARD RENOVATION

GENERAL

Description Of Work

1. This specification covers the furnishing and installation of materials for gypsum board renovation. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

Submittals

2. Quality Assurance/Control Submittals
 - a. Certificates: Manufacturer's written certification that gypsum products meet or exceed specified requirements.

Quality Assurance

3. Regulatory Requirements:
 - a. Gypsum Board Partitions: Listed and labeled for fire-protective ratings as indicated or scheduled.
 - b. Gypsum Board Floor/Ceilings and Roof/Ceiling Assemblies: Listed and labeled for fire protective ratings as indicated or scheduled.
 - c. Fire-Rated Assemblies: Comply with UL 05, FM P8016, or GA 600 for required fire-rated assembly.

Delivery, Storage, And Handling

4. Storage and Protection: Store wallboard off ground to protect it from weather and damage due to moisture damage.
 - a. Wallboard: Dry, free of warpage, and have bundling tape intact immediately prior to use.

Project Conditions

5. Environmental Requirements: Comply with Detailed Scope of Work.
 - a. During gypsum-panel application and finishing, maintain indoor temperatures within range of 13 degrees C (55 degrees F) to 21 degrees C (70 degrees F). Provide adequate ventilation to carry off excess moisture.
6. Existing Conditions: See Division 1 Section "Summary of Work". Do not interfere with use of occupied buildings or portions of buildings. Maintain free and safe passage to and from occupied areas.
7. Protection: Protect grounds, plantings, buildings and any other facilities or property from damage caused by construction operations.

Scheduling And Sequencing

8. Scheduling and Completion: Comply with Detailed Scope of Work.

PRODUCTS

Materials

9. Materials for Patching, Extending, and Matching:

- a. Provide same products or types of construction as in existing structure, as needed to patch, extend, or match existing work.
 - 1) Generally, Contract Documents will not define products present in existing construction. Determine products by Inspection and any necessary testing.
 - 2) Patching, extending, and matching of existing work and systems shall result in a complete, finished system.
- b. Presence of product, finish, or type of construction requires that patching, extending, or matching be performed as necessary to make work complete and consistent.

Metals

- 10. Partition Metals: ASTM C 645, galvanized steel:
 - a. Interior Steel Studs: Minimum 0.46 mm (25 gage), provide sizes and gages to match existing or as indicated.
 - 1) Provide minimum of 0.84 mm (20 gage) studs both sides of hollow metal frames.
 - b. Steel Stud Runners: Match studs. Provide long leg runners for slip joint at structure above to allow for deflection.
 - c. Furring Channels: Hat-shaped furring channels, minimum 0.46 mm (25 gage).
 - d. Resilient Furring Channels: Manufacturer's standard product designed to reduce sound transmission by resilient attachment of gypsum board, 13 mm (1/2 inch) deep.
 - e. Sheet-Metal Reinforcement (Alternate to Wood Blocking): 1.52 mm (16 gage) minimum.
- 11. Suspended Coiling Metals:
 - a. Runner Channels: ASTM C 754 cold-rolled steel channels with rust-inhibitive finish.
 - 1) 50 mm (2 Inches) deep, 88 kg per 100 m (590 pounds per 1,000 LF).
 - 2) 38 mm (1-1/2 inch) deep, 70 kg per 100 m (475 pounds per 1,000 LF).
 - 3) 19 mm (3/4 Inch) deep, 45 kg per 100 m (300 pounds per 1,000 LF).
 - b. Furring Channels: Hat-shaped galvanized-steel furring channels, minimum 0.46 mm (25 gage).
 - c. Steel Studs: Galvanized steel as specified above, minimum 0.46 mm (25 gage).
 - d. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper.
 - 1) Hanger Wire: Minimum 4.1 mm (8 gage).
 - 2) Tie Wire: 6 mm (16 gage).

Gypsum Board And Related Materials

- 12. Gypsum Board: GA216 and ASTM C 36
 - a. Size: 12.7 mm and 15.9 mm (1/2 inch and 5/8 inch) thick to match existing, as indicated or scheduled. Provide boards 1 200 mm (48 inches) wide by length required to minimize cross joints.
 - b. Regular Tapered-edge gypsum panels.
 - 1) Provide Type X gypsum panels at fire-rated assemblies.
 - c. Water-Resistant: ASTM C 630, paintable, tapered-edge gypsum panels.
 - 1) Provide Type X water-resistant gypsum panels at fire-rated assemblies.
- 13. Cementitious Backer Units (CBU): ANSI A118.9, nailable/screwable backer board composed of stable portland cement, aggregates, and reinforcements with ability to remain unaffected by prolonged exposure to moisture, 12.7 mm (1/2 inch) thick.
- 14. Fasteners:
 - a. Screws: ASTM C 1002, drywall screws, corrosion resistant. Provide types as recommended by manufacturer for each application.
 - 1) Wallboard to Metal Framing: Minimum 25 mm (1 inch), Type S.
 - 2) Wall board to Wood Framing: Minimum 32 mm (1-1/4 inch) Type W bugle head.

- 3) Wall board to Wallboard: Type G.
 - b. Nails: ASTM C 514.
- 15. Accessories: GA 216 and ASTM C 1047, galvanized steel.
 - a. Comer Bead: GA 216 Type CB-114 x 114.
 - b. Metal Trim (Casing Beads): GA 216 Type L, in depth to match gypsum-board thickness.
 - c. Control Joint: V-shaped control joint.
 - d. Adhesive: ASTM C 557 multi-purpose adhesive.
- 16. Finishing Materials: ASTM C 475.
 - a. Joint Tape: Provide type as recommended by panel manufacturer.
 - b. Joint Treatment: Joint compound, adhesive, water, and fasteners.
- 17. Sound-Isolation Materials:
 - a. Sound Insulation: ASTM C 665, Type I (unfaced) mineral fiber blankets, 3.7 to 4.9 kg per sq m (3/4 to 1 PCF), thickness as indicated, scheduled, or required by fire-rated assembly.
 - b. Acoustical Sealant:
 - 1) Concealed: ASTM C 919 nondrying, non-hardening, and non-skinning; non-bleeding; and non-staining.
 - 2) Exposed: ASTM C 919 non-oxidizing and skinning; permanently elastic; and paintable.
 - c. Ductwork Penetrations Packing: Low-density fiberglass.

EXECUTION

Examination

- 18. Units, Spaces, and Areas to be Renovated: Comply with Detailed Scope of Work.
 - a. Existing Conditions: Before beginning installation, examine substrates and framing to receive gypsum board for defects or conditions adversely affecting quality and execution of installation.

Preparation

- 19. Dust Protection: Comply with Detailed Scope of Work.
- 20. Building Occupation: Carry out demolition and renovation work to cause as little inconvenience to occupants as possible. See Detailed Scope of Work.
- 21. Protection: Comply with Detailed Scope of Work.
 - a. Protection: Provide drapes and drop cloths necessary to protect walls, floors, ductwork and piping, electrical work, etc. during drywall finishing operations.
- 22. Selective Demolition: Comply with Detailed Scope of Work.

Laying Out Work

- 23. Discrepancies: 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 or adjustment before work affected is performed.
 - 1) Failure to make such notification shall place responsibility on Contractor to carry out work in satisfactory, workmanlike manner.
 - c. Contractor: Responsible for location and elevation of construction indicated by Construction Documents.

Performance

24. Patching: Patch and extend existing work using skilled mechanics capable of matching existing quality of workmanship.
 - a. Quality of Patched or Extended Work: Not less than specified for new work. If similar new work is not specified, equal to existing work.
25. Damaged Surfaces: Comply with Detailed Scope of Work.
26. Transitions from Existing to New Work: Comply with Detailed Scope of Work.

Erection Of Drywall Stud Partitions

27. Reference Standard: Erect steel framing in accordance with ASTM C 754.
28. Layouts: Align partition studs accurately according to partition layout.
29. Anchoring: Anchor runner channels to concrete slabs with concrete stub nails or power-driven anchors at 600 mm (24 inches) OC. Anchor runner channels to coiling grid, where applicable, with stove bolts. Where studs extend above ceiling system, install headers where required to receive runners.
30. Studs: Position studs vertically in runners. Where studs are located adjacent to openings or partition intersections and comers. anchor studs to runners with manufacturer's metal lock fastener or with 13 mm (1/2 inch) Type S pan-head screws.
 - a. Space studs at 400 mm (16 Inches) and 600 mm (24 inches) OC as indicated or scheduled.
 - 1) Cementitious Backer Units (CBU): Space studs at maximum of 400 mm (16 inches) OC.
 - 2) Limiting Heights: Comply with ASTM C 754 for transverse load of 240 Pa (5 lb-force/SF) without exceeding either allowable stress or deflection of L/240. Comers and Intersections: Locate studs no more than 50 mm (2 inches) from abutting partitions, comers, etc.
 - b. Openings: Locate studs not more than 50 mm (2 inches) from opening frames. Anchor studs to frame anchor clips by bolt or screw attachment. Install headers over openings as recommended by the manufacturer.
 - 1) Solid-Core Wood Doors and Hollow Metal Doors: Provide two full-height studs at jambs fastened together back to back.
 - 2) Fire-Rated Openings: Comply with GA 219.
31. Bracing: Provide diagonal bracing at head of studs that terminate above the ceiling level. Bracing shall consist of metal studs bent to V-shape and extending at 45 degrees from partition head to structure above. Locate bracing 1 200 mm (48 inches) maximum OC.
32. Wood Blocking or Metal Reinforcement:
 - a. Wood Blocking: See Division 6 Section "Rough Carpentry."
 - b. Install metal reinforcement of size required for support of toilet and bath accessories, hardware, cabinets, shelving, counters, and other wall-mounted items.
 - c. Set true to line, level, or plumb well-secured in stud wall and flush with back of drywall or other wall finish.
 - d. Coordinate exact locations with other sections.

Miscellaneous Framing And Furring

33. General: Provide necessary framing and furring for special framing at recesses, offsets, specialty items, and at wall-mounted casework, shelving, and equipment.
34. Furring Channels: Install furring channels over back-up material. Position channels vertically at 600 mm (24 inches) OC. Use power-activated fasteners or stub nails at 600 mm (24 Inches) OC along alternating flanges. Shim channels level as required.
 - a. Cementitious Backer Units (CBU): Space furring at maximum of 400 mm (16 inches) OC.

35. Resilient Furring Channels: Screw-attach In accordance with manufacturer's recommendations.
 - a. Spacing: 600 mm (24 inches) OC for framing at 16 inches OC and 400 mm (16 inches) OC for framing at 24 Inches OC.

Ceiling Grillage Erection

36. Reference Standard: Erect steel framing In accordance with ASTM C 754.
37. Hangers: Install wire hangers spaced not over 1 200 mm (48 inches) OC in direction of 38 mm (1-1/2 inch) main runner channels and within 150 mm (6 inches) of ends of main runners or interruptions of ceiling continuity. Hang from structure above.
38. Runners: Place main runners not over 1 200 mm (48 inches) OC. Provide, position, and level hangers with hangers saddle-tied along runners. Space furring channels at 600 mm (24 inches) OC at right angles to runner channels and secure with furring channel clips.
39. Reinforcement: At light troffers or other openings, reinforce grillage with 19 mm (3/4 inch) cold-rolled channels wired atop and parallel to main runner channels.
 - a. Provide lateral seismic bracing as required by code.
40. Special Shapes: Provide necessary framing and suspension for off sets, verticals, etc.

Insulation

41. Sound Insulation: Place sound Insulation blankets in partitions tight within spaces, around cut openings. behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
 - a. Ductwork Penetrations: Provide one-inch wide clearance around ductwork and pack with fiberglass ready for joint sealers.

Installation Of Gypsum Drywall

42. Reference Standards: Apply and finish gypsum board in accordance with GA 216 and ASTM C 840.
43. Partition Gypsum Board Layout: Apply gypsum wallboard panels vertically with abutting ends and edges occurring over stud flanges or furring.
 - a. Joints on Opposite Sides of Partitions: Stagger; joints shall not occur over same stud.
 - b. Two Layer Construction: Stagger Joints between layers.
44. Ceiling Gypsum Board: Apply gypsum board of maximum practical length with long dimensions at right angles to furring channels. End and edge joints shall occur over furring channels with end joints staggered. Properly support gypsum board around cutouts and openings.
45. Fasteners: Apply board to studs or furring with drywall screws spaced 300 mm (12 inches) OC in field of board and 200 mm (8 inches) OC staggered along abutting edges.
46. Water-Resistant: Apply gypsum wallboard manufacturer's recommended sealant to raw cut edges and screw heads.
47. Cementitious Backer Units (CBU): Install in accordance with ANSI A108.11 and manufacturer's recommendations.
48. Accessories:
 - a. Comer Bead: Apply as recommended by manufacturer at exposed outer corners.
 - b. Trim (Casing Beads): Apply as recommended by manufacturer, where gypsum board abuts other materials, and as indicated.
 - c. Control Joints: Comply with GA 216.
 - 1) Walls: Install at not more than 9 m (30 feet) OC.
 - 2) Ceilings: Install at not more than 15 m (50 feet) OC and where framing changes direction.
 - 3) Coordinate locations with the Owner.
49. Access Panels: Securely install access panels furnished under other sections. Set plumb and square to align with finish surface.

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50. Acoustical Sealant: Seal perimeter and penetrations on both sides of sound-rated partitions and partitions with sound-attenuation blankets with minimum of single 6 mm (1/4 inch) bead of sealant
- a. Locations:
 - 1) Seal around gypsum-board perimeter in angle formed by gypsum-board panels and abutting dissimilar materials.
 - 2) Seal intersections of gypsum board with dissimilar materials.
 - 3) Seal pipe, conduit, ductwork, penetrations, etc.
 - 4) Seal around cutouts for lights, cabinets, pipes, ductwork, electrical boxes, etc.
 - 5) Seal gypsum board panel terminations in door and window frames.
 - 6) Seal control-joint locations before installing control Joints to panels.
 - b. Installation: Comply with ASTM C 919 and requirements of indicated sound-rated assembly. Provide number and positions of beads to comply with sound rating of assembly.
51. Tolerances: Gypsum-board surface plane within plus or minus 3 mm in 3 000 mm (1/8 inch in 10 feet).
52. Finishing: Finish in accordance with GA 214.
- a. Concealed Locations (Not Exposed to View in Rooms): Level 1
 - b. Beneath Tile: Level 2.
 - c. Other Finished Areas: Level 4. Finish joints, trim, and fastener dimples. Sand smooth.
 - d. Cementitious Backer Units (CBU): Treat joints in accordance with ANSI A108.11 and manufacturer's recommendations.

END OF SECTION 09 84 13 00a

SECTION 09 84 13 00b - GYPSUM BOARD SHAFT-WALL ASSEMBLIES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for gypsum board shaft-wall assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes gypsum board shaft-wall assemblies for the following:
 - a. Shaft-wall enclosures.
 - b. Chase enclosures.
 - c. Stair enclosures.
 - d. Horizontal enclosures.

C. Submittals

1. Product Data: For each gypsum board shaft-wall assembly indicated.
2. LEED Submittals:
 - a. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
 - b. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - 1) Include statement indicating costs for each product having recycled content.

D. Quality Assurance

1. Fire-Resistance Ratings: Provide materials and construction identical to those of assemblies with fire-resistance ratings determined according to ASTM E 119 by a testing and inspecting agency.
2. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.
3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling

1. Deliver materials in original packages, containers, and bundles bearing brand name and identification of manufacturer or supplier.
2. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.
3. Stack panels flat on leveled supports off floor or slab to prevent sagging.

F. Project Conditions

1. Environmental Limitations: Comply with ASTM C 840 requirements or with gypsum board manufacturer's written recommendations, whichever are more stringent.
2. Do not install interior products until installation areas are enclosed and conditioned.
3. Do not install panels that are wet, moisture damaged, or mold damaged.
 - a. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
 - b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

- A. Gypsum Board Shaft-Wall Assemblies, General
 - 1. Provide materials and components complying with requirements of fire-resistance-rated assemblies indicated.
 - a. Provide panels in maximum lengths available to eliminate or minimize end-to-end butt joints.
 - b. Provide auxiliary materials complying with gypsum board shaft-wall assembly manufacturer's written recommendations.
- B. Panel Products
 - 1. Recycled Content: Provide gypsum panel products with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
 - 2. Gypsum Liner Panels: Comply with ASTM C 442/C 442M.
 - a. Type X: Manufacturer's proprietary liner panels with moisture-resistant paper faces.
 - 1) Core: **1 inch (25.4 mm)** thick.
 - 2) Long Edges: Double bevel.
 - b. Moisture- and Mold-Resistant Type X: Manufacturer's proprietary liner panels with moisture- and mold-resistant core and surfaces; comply with ASTM D 3273.
 - 1) Core: **1 inch (25.4 mm)** thick.
 - 2) Long Edges: Double bevel.
 - 3. Gypsum Base for Gypsum Veneer Plaster: As specified in Division 09 Section "Gypsum Veneer Plastering".
 - 4. Gypsum Board: As specified in Division 09 Section "Gypsum Board".
 - 5. Water-Resistant Gypsum Backing Board: As specified in Division 09 Section "Gypsum Board".
 - 6. Cementitious Backer Units: As specified in Division 09 Section "Tiling".
- C. Non-Load-Bearing Steel Framing
 - 1. Framing Members: Comply with ASTM C 754 for conditions indicated.
 - 2. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
 - a. Recycled Content: Provide steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
 - b. Protective Coating: ASTM A 653/A 653M, **G40 (Z120) OR** ASTM A 653/A 653M, **G60 (Z180) OR** Coating with equivalent corrosion resistance of ASTM A 653/A 653M, **G40 (Z120), as directed**, hot-dip galvanized, unless otherwise indicated.
- D. Auxiliary Materials
 - 1. General: Provide auxiliary materials that comply with referenced product standards and manufacturer's written recommendations.
 - 2. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes specified in Division 09 Section(s) "Gypsum Veneer Plastering" OR "Gypsum Board", **as directed**, that comply with gypsum board shaft-wall assembly manufacturer's written recommendations for application indicated.
 - 3. Gypsum Base Joint-Reinforcing Materials: As specified in Division 09 Section "Gypsum Veneer Plastering".
 - 4. Gypsum Veneer Plaster: As specified in Division 09 Section "Gypsum Veneer Plastering".
 - 5. Gypsum Board Joint-Treatment Materials: As specified in Division 09 Section "Gypsum Board".
 - 6. Laminating Adhesive: Adhesive or joint compound recommended by manufacturer for directly adhering gypsum face-layer panels and gypsum-base face-layer panels to backing-layer panels in multilayer construction.
 - a. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 - a. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
8. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft-wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
 - a. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.
 - b. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.
9. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing), produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - a. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
 - b. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
10. Acoustical Sealant: As specified in Division 07 Section "Thermal Insulation".
 - a. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Gypsum Board Shaft-Wall Assemblies

1. Basis-of-Design Product: As indicated on Drawings by design designation of a qualified testing agency.
2. Fire-Resistance Rating: As indicated **OR** 1 hour **OR** 2 hours **OR** 3 hours **OR** 4 hours, **as directed**.
3. STC Rating: As indicated **OR** 51, minimum, **as directed**.
4. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.
 - a. Depth: As indicated **OR** 2-1/2 inches (64 mm) **OR** 4 inches (102 mm) **OR** 6 inches (152 mm), **as directed**.
 - b. Minimum Base-Metal Thickness: As indicated **OR** 0.0179 inch (0.45 mm) **OR** 0.0220 inch (0.55 mm) **OR** 0.0329 inch (0.84 mm), **as directed**.
5. Runner Tracks: Manufacturer's standard J-profile track with long-leg length as standard with manufacturer, but at least 2 inches (51 mm) long and in depth matching studs.
 - a. Minimum Base-Metal Thickness: As indicated **OR** Matching steel studs **OR** 0.0179 inch (0.45 mm) **OR** 0.0220 inch (0.55 mm) **OR** 0.0329 inch (0.84 mm), **as directed**.
6. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
7. Jamb Struts: Manufacturer's standard J-profile strut with long-leg length of 3 inches (76 mm), in depth matching studs, and not less than 0.0329 inch (0.84 mm) thick.
8. Room-Side Finish: As indicated **OR** Gypsum board **OR** Gypsum veneer plaster **OR** Cementitious backer units, **as directed**.
9. Shaft-Side Finish: As indicated **OR** As indicated by fire-resistance-rated assembly design designation, **as directed**.
10. Insulation: Sound attenuation blankets.

2.2 EXECUTION

A. Preparation

1. Sprayed Fire-Resistive Materials: Coordinate with gypsum board shaft-wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft-wall assemblies to comply with requirements specified in Division 07 Section "Applied Fireproofing".
 - a. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runner tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than **24 inches (610 mm)** o.c.
2. After sprayed fire-resistive materials are applied, remove only to extent necessary for installation of gypsum board shaft-wall assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

B. Installation

1. General: Install gypsum board shaft-wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and the following:
 - a. ASTM C 754 for installing steel framing except comply with framing spacing indicated.
 - b. Division 09 Section(s) "Gypsum Veneer Plastering" OR "Gypsum Board", **as directed**, for applying and finishing panels.
 - c. Division 09 Section "Tiling" for cementitious backer units.
2. Do not bridge architectural or building expansion joints with shaft-wall assemblies; frame both sides of expansion joints with furring and other support.
3. Install supplementary framing in gypsum board shaft-wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, and similar items that cannot be supported directly by shaft-wall assembly framing.
 - a. At elevator hoistway entrance door frames, provide jamb struts on each side of door frame.
 - b. Where handrails directly attach to gypsum board shaft-wall assemblies, provide galvanized steel reinforcing strip with **0.0312-inch (0.79-mm)** minimum thickness of base (uncoated) metal, accurately positioned and secured behind at least 1 gypsum base for veneer plaster **OR** gypsum board **OR** cementitious backer unit, **as directed**, face-layer panel.
4. Integrate stair hanger rods with gypsum board shaft-wall assemblies by locating cavity of assemblies where required to enclose rods.
5. At penetrations in shaft wall, maintain fire-resistance rating of shaft-wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.
6. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels, while maintaining continuity of fire-rated construction.
7. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
8. Control Joints: Install control joints at locations indicated on Drawings **OR** according to ASTM C 840 and in specific locations approved by the Owner, **as directed**, while maintaining fire-resistance rating of gypsum board shaft-wall assemblies.
9. Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly. Install acoustical sealant to withstand dislocation by air-pressure differential between shaft and external spaces; maintain an airtight and smoke-tight seal; and comply with ASTM C 919 requirements or with manufacturer's written instructions, whichever are more stringent.
10. In elevator shafts where gypsum board shaft-wall assemblies cannot be positioned within **4 inches (102 mm)** of the shaft face of structural beams, floor edges, and similar projections into shaft, install **1/2- or 5/8-inch- (13- or 16-mm-)** thick, gypsum board cants covering tops of projections. No recesses allowed (at steel beams especially).

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- a. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at **24 inches (610 mm)** o.c. with screws fastened to shaft-wall framing.
 - b. Where steel framing is required to support gypsum board cants, install framing at **24 inches (610 mm)** o.c. and extend studs from the projection to shaft-wall framing.
 11. Installation Tolerance: Install each framing member so fastening surfaces vary not more than **1/8 inch (3mm)** from the plane formed by faces of adjacent framing.
- C. Protection
1. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
 2. Remove and replace panels that are wet, moisture damaged, or mold damaged.
 - a. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
 - b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 84 13 00b

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SECTION 09 84 13 00c - ACOUSTICAL WALL PANELS

1.1 GENERAL

A. Description Of Work

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

B. Summary

1. This Section includes spline-mounted **OR** back-mounted, **as directed**, acoustical wall panels.

C. Definitions

1. NRC: Noise reduction coefficient.

D. Submittals

1. Product Data: For each type of panel edge, core material, and mounting indicated.
2. Shop Drawings: For acoustical wall panels. Include mounting devices and details.
3. Coordination Drawings: Show intersections with adjacent work.
4. Samples: For each fabric and sample panels.
5. LEED Submittal:
 - a. Product Data for Credit EQ 4.1: For installation adhesive, including printed statement of VOC content.
6. Product certificates **OR** test reports, **as directed**.
7. Maintenance data.
8. Warranty: Special warranty specified in this Section.

E. Quality Assurance

1. Fire-Test-Response Characteristics: Provide acoustical wall panels with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 **OR** IBC Chapter 8, **as directed**, by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
2. Fire Growth Contribution: Meeting acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 **OR** NFPA 286, **as directed**.
3. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling

1. Comply with fabric and acoustical wall panel manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.
2. Deliver materials and panels in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.
3. Protect panel edges from crushing and impact.

G. Project Conditions

1. Environmental Limitations: Do not install acoustical wall panels until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
2. Lighting: Do not install acoustical wall panels until a permanent level of lighting **OR** a lighting level of not less than 50 fc (538 lux), **as directed**, is provided on surfaces to receive acoustical wall panels.

3. Air-Quality Limitations: Protect acoustical wall panels from exposure to airborne odors, such as tobacco smoke, and install panels under conditions free from odor contamination of ambient air.
4. Field Measurements: Verify locations of acoustical wall panels by field measurements before fabrication and indicate measurements on Shop Drawings.

H. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of acoustical wall panels that fail in performance, materials, or workmanship within two years from date of Final Completion.
 - a. Failure in performance includes, but is not limited to, acoustical performance.
 - b. Failures in materials include, but are not limited to, fabric sagging, distorting, or releasing from panel edge; or warping of core.

1.2 PRODUCTS

A. Core Materials

1. Glass-Fiber Board: ASTM C 612, Type IA or Types IA and IB; density as specified, unfaced, dimensionally stable, molded rigid board, with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
2. Mineral-Fiber Board: Maximum flame-spread and smoke-developed indexes of 15 and 5, respectively.
3. Cementitious-Fiber Board Core: Density of not less than 20 lb/cu. ft. (320 kg/cu. m).
4. Tackable, Impact-Resistant, High-Density Face Layer: 1/8-inch- (3.2-mm-) thick layer of compressed molded glass-fiber board with a minimum nominal density of 16 to 18 lb/cu. ft. (256 to 288 kg/cu. m) laminated to face of core.
5. Impact-Resistant, Acoustically Transparent, Copolymer Face-Sheet Layer for High-Abuse Applications: 1/16- to 1/8-inch- (1.6- to 3.2-mm-) thick layer of perforated, noncombustible, copolymer sheet laminated to face of core.
6. Wood: Clear, vertical grain, straight, kiln-dried hardwood of manufacturer's standard species, AWPAC20, Interior Type A, fire-retardant treated, low-hygroscopic-type formulation. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Kiln-dry material after treatment to 5 to 10 percent moisture content.

B. Spline-Mounted Acoustical Wall Panels With Perforated Mineral-Fiber Board Core Or Cementitious-Fiber Board Core

1. Panel Construction: Manufacturer's standard panel construction consisting of facing material laminated to front face of a perforated, water-felted, mineral-fiber board **OR** cementitious-fiber board, **as directed**, core; with long edges kerfed and rabbeted to receive splines.
 - a. Mineral-Fiber Board: Not less than 13-lb/cu. ft. (208-kg/cu. m) **OR** 20-lb/cu. ft. (320-kg/cu. m), **as directed**, nominal density; with perforated surface.
2. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations **OR** matching samples **OR** as selected from manufacturer's full range **OR** as indicated on Drawings, **as directed**.
 - a. Fiber Content: 100 percent woven polyester **OR** nonwoven polyester **OR** polyolefin **OR** acoustically transparent vinyl, **as directed**.
 - b. Width: 54 inches (1371 mm) **OR** 66 inches (1676 mm), **as directed**.
 - c. Applied Treatments: Stain resistance.
3. Nominal Overall Panel Thickness: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**.
4. NRC: For Type A mounting per ASTM E 795, NRC 0.50 to NRC 0.90 **OR** NRC 0.60 to NRC 0.70 **OR** NRC 0.65 to NRC 0.75, **as directed**.
5. Panel Width: 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** 48 inches (1220 mm) **OR** 600 mm **OR** As indicated on Drawings, **as directed**.
6. Panel Height: Fabricated from units 96 inches (2438 mm) **OR** 108 inches (2743 mm) **OR** 120 inches (3048 mm), **as directed**, in height; mounting height **as directed**.

7. Panel Edge: Core self-edge.
 8. Panel Short Edge Detail: Square.
- C. Spline-Mounted Acoustical Wall Panels With Glass-Fiber Board Core
1. Panel Construction: Manufacturer's standard panel construction consisting of facing material laminated to front face of a dimensionally stable, rigid glass-fiber board core with a nominal density of **6 to 7 lb/cu. ft. (96 to 112 kg/cu. m)**; with long edges kerfed and rabbeted to receive splines.
 2. Core-Face Layer: Tackable, impact-resistant, high-density board **OR** Impact-resistant, acoustically transparent, copolymer face-sheet, **as directed**.
 3. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations **OR** matching samples **OR** as selected from manufacturer's full range **OR** as indicated on Drawings, **as directed**.
 - a. Fiber Content: 100 percent woven polyester **OR** nonwoven polyester **OR** polyolefin **OR** acoustically transparent vinyl, **as directed**.
 - b. Width: **54 inches (1371 mm) OR 66 inches (1676 mm)**, **as directed**.
 - c. Applied Treatments: Stain resistance.
 4. Nominal Overall Panel Thickness: **3/4 inch (19 mm) OR 1 inch (25 mm) OR 1-1/2 inches (38 mm) OR 2 inches (51 mm)**, **as directed**.
 5. NRC: For Type A mounting per ASTM E 795, not less than NRC 0.20 **OR** NRC 0.80 **OR** NRC 0.95, **as directed**.
 6. Panel Width: Manufacturer's standard **OR 24 inches (610 mm) OR 30 inches (762 mm) OR 48 inches (1220 mm) OR 600 mm OR 1200 mm OR** As indicated on Drawings, **as directed**.
 7. Panel Height: Fabricated from units **96 inches (2438 mm) OR 108 inches (2743 mm) OR 120 inches (3048 mm)**, **as directed**, in height; mounting height **as directed**.
 8. Panel Edge: Manufacturer's standard short edge.
 9. Panel Short Edge Detail: Square.
- D. Back-Mounted Acoustical Wall Panels With Perforated Mineral-Fiber Board Core
1. Panel Construction: Manufacturer's standard panel construction consisting of facing material laminated to front face of a perforated, water-felted, mineral-fiber board core of not less than **13-lb/cu. ft. (208-kg/cu. m) OR 20-lb/cu. ft. (320-kg/cu. m)**, **as directed**, nominal density; with perforated surface.
 2. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations **OR** matching samples **OR** as selected from manufacturer's full range **OR** as indicated on Drawings, **as directed**.
 - a. Fiber Content: 100 percent woven polyester **OR** nonwoven polyester **OR** polyolefin **OR** acoustically transparent vinyl, **as directed**.
 - b. Width: **54 inches (1371 mm) OR 66 inches (1676 mm)**, **as directed**.
 - c. Applied Treatments: Stain resistance.
 3. Nominal Core Thickness and Overall System NRC: **1/2 inch (13 mm)** and not less than NRC 0.35 **OR 3/4 inch (19 mm)** and not less than NRC 0.45, **as directed**, for Type A mounting.
 4. Panel Width: **24 inches (610 mm) OR 30 inches (762 mm) OR 48 inches (1220 mm) OR 600 mm OR** As indicated on Drawings, **as directed**.
 5. Panel Height: Fabricated from units **96 inches (2438 mm) OR 108 inches (2743 mm) OR 120 inches (3048 mm)**, **as directed**, in height; mounting height **as directed**.
 6. Panel Edge: Core self-edge.
 7. Panel Short Edge Detail: Square.
- E. Back-Mounted, Edge-Reinforced Acoustical Wall Panels With Glass-Fiber Board Core
1. Panel Construction: Manufacturer's standard panel construction consisting of facing material laminated to front face, edges, and back border of dimensionally stable, rigid glass-fiber **OR** rock-fiber/slag-fiber, **as directed**, board core; with edges chemically hardened or impact resistant and resilient to reinforce panel perimeter against warpage and damage.
 2. Nominal Core Density: **4 to 7 lb/cu. ft. (64 to 112 kg/cu. m) OR 6 to 7 lb/cu. ft. (96 to 112 kg/cu. m)**, **as directed**.

3. Core-Face Layer: Tackable, impact-resistant, high-density board **OR** Impact-resistant, acoustically transparent, copolymer face-sheet, **as directed**.
 4. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations **OR** matching samples **OR** as selected from manufacturer's full range **OR** as indicated on Drawings, **as directed**.
 - a. Fiber Content: 100 percent woven polyester **OR** nonwoven polyester **OR** polyolefin **OR** acoustically transparent vinyl, **as directed**.
 - b. Width: **54 inches (1371 mm)** **OR** **66 inches (1676 mm)**, **as directed**.
 - c. Applied Treatments: Stain resistance.
 5. Nominal Core Thickness and Overall System NRC: **3/4 inch (19 mm)** and not less than NRC 0.65 **OR** **1 inch (25 mm)** and not less than NRC 0.80 **OR** **1-1/2 inches (38 mm)** and not less than NRC 0.85 **OR** **2 inches (51 mm)** and not less than NRC 0.90 **OR** **2 inches (51 mm)** and not less than NRC 1.00, **as directed**, for Type A mounting per ASTM E 795.
 6. Panel Width: Manufacturer's standard **OR** **24 inches (610 mm)** **OR** **30 inches (762 mm)** **OR** **48 inches (1220 mm)** **OR** 600 mm **OR** 1200 mm **OR** As indicated on Drawings, **as directed**.
 7. Panel Height: Fabricated height as indicated on Drawings **OR as directed**; mounting height as indicated on Drawings **OR as directed**.
 8. Panel Edge Detail: Square **OR** Bullnosed (radiused) **OR** Chamfered (beveled) **OR** Mitered **OR** Custom as indicated on Drawings, **as directed**.
 9. Corner Detail: Square **OR** Round, radius as indicated **OR** Off-square, dimensions as indicated, **as directed**, to form continuous profile to match edge detail.
- F. Back-Mounted, Edge-Framed Acoustical Wall Panels With Glass-Fiber Board Core
1. Panel Construction: Manufacturer's standard panel construction consisting of facing material stretched over front face of edge-framed, dimensionally stable, rigid glass-fiber board core and bonded or attached to edges and back of frame.
 2. Nominal Core Density: **4 to 7 lb/cu. ft. (64 to 112 kg/cu. m)** **OR** **6 to 7 lb/cu. ft. (96 to 112 kg/cu. m)**, **as directed**.
 3. Core-Face Layer: Tackable, impact-resistant, high-density board **OR** Impact-resistant, acoustically transparent, copolymer face-sheet, **as directed**.
 4. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations **OR** matching samples **OR** as selected from manufacturer's full range **OR** as indicated on Drawings, **as directed**.
 - a. Fiber Content: 100 percent woven polyester **OR** nonwoven polyester **OR** polyolefin **OR** acoustically transparent vinyl, **as directed**.
 - b. Width: **54 inches (1371 mm)** **OR** **66 inches (1676 mm)**, **as directed**.
 - c. Applied Treatments: Stain resistance.
 5. Nominal Core Thickness and Overall System NRC: **1 inch (25 mm)** and not less than NRC 0.80 **OR** **1-1/2 inches (38 mm)** and not less than NRC 0.85 **OR** **2 inches (51 mm)** and not less than NRC 0.90, **as directed**, for Type A mounting per ASTM E 795.
 6. Panel Width: Manufacturer's standard **OR** **24 inches (610 mm)** **OR** **30 inches (762 mm)** **OR** **48 inches (1220 mm)** **OR** 600 mm **OR** 1200 mm **OR** As indicated on Drawings, **as directed**.
 7. Panel Height: Fabricated height as indicated on Drawings **OR as directed**; mounting height as indicated on Drawings **OR as directed**.
 8. Panel Edge and Frame: Extruded-aluminum or zinc-coated, rolled-steel shape **OR** Extruded PVC **OR** Hardwood, rabbeted, and splined with glued joints and machined corners, **as directed**.
 - a. Panel Edge Detail: Square.
- G. Fabrication
1. Sound-Absorption Performance: Provide acoustical wall panels with minimum NRCs indicated, as determined by testing per ASTM C 423 for mounting type specified.
 2. Acoustical Wall Panels: Panel construction consisting of facing material adhered to face, **as directed**, edges and back border of dimensionally stable core; with rigid edges to reinforce panel perimeter against warpage and damage.
 - a. Glass-Fiber Board: Resin harden areas of core for attachment of mounting devices.

3. Fabric Facing: Stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other foreign matter. Applied with visible surfaces fully covered.
 - a. Where square corners are indicated, tailor corners. Heat seal vinyl fabric seams at corners.
 - b. Where radius or other nonsquare corners are indicated, attach facing material so there are no seams or gathering of material.
 - c. Where fabrics with directional or repeating patterns or directional weave are indicated, mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent panels.
4. Core-Face Layer: Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, sags.
5. Dimensional Tolerances of Finished Units: Plus or minus **1/16 inch (1.6 mm)** for the following:
 - a. Thickness.
 - b. Edge straightness.
 - c. Overall length and width.
 - d. Squareness from corner to corner.
 - e. Chords, radii, and diameters.
6. Spline-Mounting Accessories: Manufacturer's standard concealed, extruded-aluminum or plastic connecting splines designed and fabricated for screw attachment to walls, with other moldings and trim for interior and exterior corners, leveling and base support with factory-applied finish on exposed items.
 - a. Finish Color: White **OR** Black **OR** Match color of facing material **OR** Match sample, **as directed**.
7. Back-Mounting Devices: Concealed on backside of panel, recommended to support weight of panel, with base-support bracket system where recommended by manufacturer for additional support of panels, and as follows:
 - a. Adhesive. Use only adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Hook-and-loop tape.
 - c. Impaling clips.
 - d. Magnetic strip or devices.
 - e. Metal "Z" Clips: Two-part panel clips, with one part of each clip mechanically attached to back of panel and the other part to wall substrate, designed to allow for panel removal.
 - f. As recommended by manufacturer.
8. Owner-Furnished Fabric: Provide fabric acceptable to acoustical wall panel manufacturer for application indicated. Notify the Owner of fabric unacceptability.

1.3 EXECUTION

A. Installation

1. Install acoustical wall panels in locations indicated with vertical surfaces and edges plumb, top edges level and in alignment with other panels, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
 - a. Cut units to be at least 50 percent of unit width, with facing material extended over cut edge to match uncut edge. Scribe acoustical wall panels to fit adjacent work. Butt joints tightly.
2. Comply with acoustical wall panel manufacturer's written instructions for installation of panels using type of concealed mounting accessories indicated or, if not indicated, as recommended by manufacturer. Anchor panels securely to supporting substrate.
3. Match and level fabric pattern and grain among adjacent panels.
4. Installation Tolerances: As follows:
 - a. Variation from Level and Plumb: Plus or minus **1/16 inch (1.6 mm)**.
 - b. Variation of Panel Joints from Hairline: Not more than **1/16 inch (1.6 mm) OR 1/32 inch (0.79 mm)**, **as directed**, wide.

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- B. Cleaning
 - 1. Clip loose threads; remove pills and extraneous materials.
 - 2. Clean panels with fabric facing, on completion of installation, to remove dust and other foreign materials according to manufacturer's written instructions.
 - C. Protection
 - 1. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to ensure that acoustical wall panels are without damage or deterioration at time of Final Completion.
 - 2. Replace acoustical wall panels that cannot be cleaned and repaired, in a manner approved by the Owner, before time of Final Completion.

END OF SECTION 09 84 13 00c

SECTION 09 91 13 00 - EXTERIOR PAINTING

1.1 GENERAL

A. Description Of Work

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

B. Summary

1. This Section includes surface preparation and the application of paint systems on the following exterior substrates:
 - a. Concrete.
 - b. Clay masonry.
 - c. Concrete masonry units (CMU).
 - d. Steel.
 - e. Galvanized metal.
 - f. Aluminum (not anodized or otherwise coated).
 - g. Wood.
 - h. Plastic trim fabrications.
 - i. Exterior portland cement (stucco).
 - j. Exterior gypsum board.

C. Submittals

1. Product Data: For each type of product indicated.
2. Samples: For each finish and for each color and texture required.
3. Product List: Printout of current "MPI Approved Products List" for each product category specified in Part 1.2, with the proposed product highlighted.

D. Quality Assurance

1. MPI Standards:
 - a. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
 - b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated. For renovation projects, comply with requirements of "MPI Maintenance Repainting Manual" for products and paint systems indicated.
2. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - a. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - 1) Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
 - 2) Other Items: Architect will designate items or areas required.
 - b. Final approval of color selections will be based on mockups.
 - 1) If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
 - c. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - d. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

- E. Delivery, Storage, And Handling
 - 1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **45 deg F (7 deg C)**.
 - a. Maintain containers in clean condition, free of foreign materials and residue.
 - b. Remove rags and waste from storage areas daily.
- F. Project Conditions
 - 1. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between **50 and 95 deg F (10 and 35 deg C)**.
 - 2. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than **5 deg F (3 deg C)** above the dew point; or to damp or wet surfaces.

1.2 PRODUCTS

- A. Paint, General
 - 1. Material Compatibility:
 - a. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - b. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
 - 2. Colors: As selected from manufacturer's full range.
- B. Block Fillers
 - 1. Interior/Exterior Latex Block Filler: MPI #4.
 - a. VOC Content: E Range of E2 **OR** E3, **as directed**.
- C. Primers/Sealers
 - 1. Alkali-Resistant Primer: MPI #3.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - 2. Bonding Primer (Water Based): MPI #17.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - 3. Bonding Primer (Solvent Based): MPI #69.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - 4. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for use in paint system indicated.
- D. Metal Primers
 - 1. Alkyd Anticorrosive Metal Primer: MPI #79.
 - a. VOC Content: E Range of E1 **OR** E2, **as directed**.
 - 2. Quick-Drying Alkyd Metal Primer: MPI #76.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - 3. Cementitious Galvanized-Metal Primer: MPI #26.
 - a. VOC Content: E Range of E1.
 - 4. Waterborne Galvanized-Metal Primer: MPI #134.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
 - 5. Quick-Drying Primer for Aluminum: MPI #95.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
- E. Wood Primers
 - 1. Exterior Latex Wood Primer: MPI #6.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - 2. Exterior Alkyd Wood Primer: MPI #5.

- a. VOC Content: E Range of E2 **OR** E3, **as directed**.
- 3. Exterior Oil Wood Primer: MPI #7.
 - a. VOC Content: E Range of E2.
- F. Exterior Latex Paints
 - 1. Exterior Latex (Flat): MPI #10 (Gloss Level 1).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - 2. Exterior Latex (Semigloss): MPI #11 (Gloss Level 5).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - 3. Exterior Latex (Gloss): MPI #119 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
- G. Exterior Alkyd Paints
 - 1. Exterior Alkyd Enamel (Flat): MPI #8 (Gloss Level 1).
 - a. VOC Content: E Range of E1.
 - 2. Exterior Alkyd Enamel (Semigloss): MPI #94 (Gloss Level 5).
 - a. VOC Content: E Range of E1 **OR** E2, **as directed**.
 - 3. Exterior Alkyd Enamel (Gloss): MPI #9 (Gloss Level 6).
 - a. VOC Content: E Range of E1 **OR** E2, **as directed**.
- H. Quick-Drying Enamels
 - 1. Quick-Drying Enamel (Semigloss): MPI #81 (Gloss Level 5).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - 2. Quick-Drying Enamel (High Gloss): MPI #96 (Gloss Level 7).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
- I. Textured And High-Build Coatings
 - 1. Latex Stucco and Masonry Textured Coating: MPI #42.
 - a. VOC Content: E Range of E2 **OR** E3, **as directed**.
 - 2. High-Build Latex (Exterior): MPI #40.
 - a. VOC Content: E Range of E1 **OR** E3, **as directed**.
- J. Aluminum Paint
 - 1. Aluminum Paint: MPI #1.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
- K. Floor Coatings
 - 1. Interior/Exterior Clear Concrete Floor Sealer (Water Based): MPI #99.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - 2. Interior/Exterior Clear Concrete Floor Sealer (Solvent Based): MPI #104.
 - a. VOC Content: E Range of E1 **OR** E2, **as directed**.
 - 3. Interior/Exterior Latex Floor and Porch Paint (Low Gloss): MPI #60 (maximum Gloss Level 3).
 - a. VOC Content: E Range of E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 3.
 - 4. Exterior/Interior Alkyd Floor Enamel (Gloss): MPI #27 (Gloss Level 6).
 - a. VOC Content: E Range of E1 **OR** E2, **as directed**.
 - b. Additives: Manufacturer's standard additive to increase skid resistance of painted surface.

1.3 EXECUTION

- A. Examination
 - 1. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
 - 2. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

- a. Concrete: 12 percent.
- b. Masonry (Clay and CMU): 12 percent.
- c. Wood: 15 percent.
- d. Plaster: 12 percent.
- e. Gypsum Board: 12 percent.
- 3. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- 4. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 - a. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

B. Preparation And Application

- 1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- 2. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
 - a. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
- 3. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- 4. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- 5. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

C. Exterior Painting Schedule

- 1. Paint systems herein are based on "MPI Architectural Painting Specification Manual" (hereafter, "MPI Manual"). For renovation projects, consult "MPI Maintenance Repainting Manual" and revise paint systems accordingly.
- 2. For a Premium Grade system, "MPI Manual" requires intermediate coat; if Custom Grade system is required or if so directed, delete intermediate coat, **unless directed otherwise** or as otherwise required by manufacturer's recommendations.
- 3. Concrete Substrates, Nontraffic Surfaces:
 - a. Latex System: MPI EXT 3.1A.
 - 1) Prime Coat: Exterior latex matching topcoat.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Latex Aggregate/Latex System: MPI EXT 3.1 B.
 - 1) Prime Coat: Latex stucco and masonry textured coating.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Latex Over Alkali-Resistant Primer System: MPI EXT 3.1K.
 - 1) Prime Coat: Alkali-resistant primer.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - d. High-Build Latex System: MPI EXT 3.1L, applied to form dry film thickness of not less than **10 mils (0.25 mm)**.
 - 1) Prime Coat: As recommended in writing by topcoat manufacturer.
 - 2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - 3) Topcoat: High-build latex (exterior).
 - e. Latex Aggregate System: MPI EXT 3.1N.
 - 1) Prime Coat: As recommended in writing by topcoat manufacturer.

- 2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
- 3) Topcoat: Latex stucco and masonry textured coating.
4. Concrete Substrates, Traffic Surfaces:
 - a. Latex Floor Paint System: MPI EXT 3.2A.
 - 1) Prime Coat: Interior/exterior latex floor and porch paint (low gloss).
 - 2) Intermediate Coat: Interior/exterior latex floor and porch paint (low gloss).
 - 3) Topcoat: Interior/exterior latex floor and porch paint (low gloss).
 - b. Alkyd Floor Enamel System: MPI EXT 3.2D.
 - 1) Prime Coat: Exterior/interior alkyd floor enamel (gloss).
 - 2) Intermediate Coat: Exterior/interior alkyd floor enamel (gloss).
 - 3) Topcoat: Exterior/interior alkyd floor enamel (gloss).
 - c. Clear Sealer System: MPI EXT 3.2G.
 - 1) Prime Coat: Interior/exterior clear concrete floor sealer (solvent based).
 - 2) Intermediate Coat: Interior/exterior clear concrete floor sealer (solvent based).
 - 3) Topcoat: Interior/exterior clear concrete floor sealer (solvent based).
 - d. Water-Based Clear Sealer System: MPI EXT 3.2H.
 - 1) Prime Coat: Interior/exterior clear concrete floor sealer (water based).
 - 2) Intermediate Coat: Interior/exterior clear concrete floor sealer (water based).
 - 3) Topcoat: Interior/exterior clear concrete floor sealer (water based).
5. Clay-Masonry Substrates:
 - a. Latex System: MPI EXT 4.1A.
 - 1) Prime Coat: Exterior latex matching topcoat.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. High-Build Latex System: MPI EXT 4.1H, applied to form dry film thickness of not less than **10 mils (0.25 mm)**.
 - 1) Prime Coat: As recommended in writing by topcoat manufacturer.
 - 2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - 3) Topcoat: High-build latex (exterior).
 - c. Latex Aggregate System: MPI EXT 4.1B.
 - 1) Prime Coat: As recommended in writing by topcoat manufacturer.
 - 2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - 3) Topcoat: Latex stucco and masonry textured coating.
6. CMU Substrates:
 - a. Latex System: MPI EXT 4.2A.
 - 1) Prime Coat: Interior/exterior latex block filler.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Latex Over Alkali-Resistant Primer System: MPI EXT 4.2L.
 - 1) Prime Coat: Alkali-resistant primer.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. High-Build Latex System: MPI EXT 4.2K, applied to form dry film thickness of not less than **10 mils (0.25 mm)**.
 - 1) Prime Coat: As recommended in writing by topcoat manufacturer.
 - 2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - 3) Topcoat: High-build latex (exterior).
 - d. Latex Aggregate System: MPI EXT 4.2B.
 - 1) Prime Coat: As recommended in writing by topcoat manufacturer.
 - 2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - 3) Topcoat: Latex stucco and masonry textured coating.
7. Steel Substrates:
 - a. Quick-Drying Enamel System: MPI EXT 5.1A.
 - 1) Prime Coat: Quick-drying alkyd metal primer.
 - 2) Intermediate Coat: Quick-drying enamel matching topcoat.
 - 3) Topcoat: Quick-drying enamel (semigloss) **OR** (high gloss), **as directed**.

- b. Alkyd System: MPI EXT 5.1D.
 - 1) Prime Coat: Alkyd anticorrosive metal primer.
 - 2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - 3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Aluminum Paint System: MPI EXT 5.1K.
 - 1) Prime Coat: Alkyd anticorrosive metal primer.
 - 2) Intermediate Coat: Aluminum paint.
 - 3) Topcoat: Aluminum paint.
 - 8. Galvanized-Metal Substrates: Galvanized-metal substrates should not be chromate passivated (commercially known as "bonderized") if primer is field applied. If galvanized metal is chromate passivated, consult manufacturers for appropriate surface preparation and primers.
 - a. Latex System: MPI EXT 5.3A.
 - 1) Prime Coat: Cementitious galvanized-metal primer.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Latex Over Water-Based Primer System: MPI EXT 5.3H. "MPI Manual" recommends latex over water-based primer system for low-contact/traffic areas.
 - 1) Prime Coat: Waterborne galvanized-metal primer.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Alkyd System: MPI EXT 5.3B.
 - 1) Prime Coat: Cementitious galvanized-metal primer.
 - 2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - 3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - 9. Aluminum Substrates:
 - a. Latex System: MPI EXT 5.4H.
 - 1) Prime Coat: Quick-drying primer for aluminum.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Alkyd System: MPI EXT 5.4F.
 - 1) Prime Coat: Quick-drying primer for aluminum.
 - 2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - 3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - 10. Glue-Laminated Beam and Column Substrates:
 - a. Latex System: MPI EXT 6.1L.
 - 1) Prime Coat: Exterior latex wood primer.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Latex Over Alkyd Primer System: MPI EXT 6.1A.
 - 1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Alkyd System: MPI EXT 6.1B.
 - 1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
 - 2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - 3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - 11. Dressed Lumber Substrates: Including architectural woodwork **OR** doors, **as directed**.
 - a. Latex System: MPI EXT 6.3L.
 - 1) Prime Coat: Exterior latex wood primer.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**. Flat paint is not recommended for use on doors.
 - b. Latex Over Alkyd Primer System: MPI EXT 6.3A.
 - 1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
 - 2) Intermediate Coat: Exterior latex matching topcoat.

- 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**. Flat paint is not recommended for use on doors.
- c. Alkyd System: MPI EXT 6.3B.
 - 1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
 - 2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - 3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**. Flat paint is not recommended for use on doors.
12. Wood Panel Substrates: Including plywood siding **OR** fascias **OR** soffits, **as directed**.
 - a. Latex System: MPI EXT 6.4K.
 - 1) Prime Coat: Exterior latex wood primer.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Latex Over Alkyd Primer System: MPI EXT 6.4G.
 - 1) Prime Coat: Exterior alkyd wood primer.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Alkyd System: MPI EXT 6.4B.
 - 1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
 - 2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - 3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
13. Wood Shingle and Shake Substrates (Excluding Roofs):
 - a. Latex System: MPI EXT 6.6E.
 - 1) Prime Coat: Exterior latex wood primer.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Latex Over Alkyd Primer System: MPI EXT 6.6A.
 - 1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Alkyd System: MPI EXT 6.6B.
 - 1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
 - 2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - 3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
14. Dimension Lumber Substrates, Nontraffic Surfaces: Including board siding **OR** fencing **OR** undersides of decking, **as directed**.
 - a. Latex System: MPI EXT 6.2M.
 - 1) Prime Coat: Exterior latex wood primer.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Latex Over Alkyd Primer System: MPI EXT 6.2A.
 - 1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Alkyd System: MPI EXT 6.2C.
 - 1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
 - 2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - 3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
15. Dimension Lumber Substrates, Traffic Surfaces: Including lumber decking **OR** stairs, **as directed**.
 - a. Latex System: MPI EXT 6.5E.
 - 1) Prime Coat: Exterior latex wood primer.
 - 2) Intermediate Coat: Interior/exterior latex floor and porch (low gloss).
 - 3) Topcoat: Interior/exterior latex floor and porch (low gloss).
 - a) With additive to increase skid resistance of painted surface.
 - b. Latex Over Alkyd Primer System: MPI EXT 6.5A.
 - 1) Prime Coat: Exterior alkyd wood primer.

- 2) Intermediate Coat: Interior/exterior latex floor and porch (low gloss).
- 3) Topcoat: Interior/exterior latex floor and porch (low gloss).
 - a) With additive to increase skid resistance of painted surface.
- c. Alkyd Floor Enamel System: MPI EXT 6.5B.
 - 1) Prime Coat: Exterior/interior alkyd floor enamel (gloss).
 - 2) Intermediate Coat: Exterior/interior alkyd floor enamel (gloss).
 - 3) Topcoat: Exterior/interior alkyd floor enamel (gloss).
 - a) With additive to increase skid resistance of painted surface.
16. Plastic Trim Fabrication Substrates:
 - a. Latex System: MPI EXT 6.8A.
 - 1) Prime Coat: Bonding primer (water based) **OR** (solvent based), **as directed**.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Alkyd System: MPI EXT 6.8B.
 - 1) Prime Coat: Bonding primer (water based) **OR** (solvent based), **as directed**.
 - 2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - 3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
17. Stucco Substrates:
 - a. Latex System: MPI EXT 9.1A.
 - 1) Prime Coat: Exterior latex matching topcoat.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Latex Over Alkali-Resistant Primer System: MPI EXT 9.1J.
 - 1) Prime Coat: Alkali-resistant primer.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. High-Build Latex System: MPI EXT 9.1H, applied to form dry film thickness of not less than **10 mils (0.25 mm)**.
 - 1) Prime Coat: As recommended in writing by topcoat manufacturer.
 - 2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - 3) Topcoat: High-build latex (exterior).
18. Exterior Gypsum Board Substrates:
 - a. Latex System: MPI EXT 9.2A.
 - 1) Prime Coat: Exterior latex matching topcoat.
 - 2) Intermediate Coat: Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

END OF SECTION 09 91 13 00

SECTION 09 91 13 00a - HIGH-TEMPERATURE-RESISTANT COATINGS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for high-temperature-resistant coatings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. This Section includes surface preparation and application of high-temperature-resistant coating systems on steel substrates subject to high temperatures.

C. Submittals

1. Product Data: For each type of product indicated.
2. Samples: For each coating and for each color and texture required.
3. LEED Submittal:
 - a. Product Data for Credit EQ 4.2: For coatings, including printed statement of VOC content and chemical components.

D. Quality Assurance

1. Master Painters Institute (MPI) Standards:
 - a. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List" **OR** "MPI Maintenance Repainting Manual," **as directed**.
 - b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" **OR** "MPI Maintenance Repainting Manual," **as directed**, for products and coating systems indicated.

E. Delivery, Storage, And Handling

1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **45 deg F (7 deg C)**.
 - a. Maintain containers in clean condition, free of foreign materials and residue.
 - b. Remove rags and waste from storage areas daily.

F. Project Conditions

1. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between **50 and 104 deg F (10 and 40 deg C)**.
2. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than **5 deg F (3 deg C)** above the dew point; or to damp or wet surfaces.

1.2 PRODUCTS

A. High-Temperature-Resistant Coatings

1. VOC Content of Interior Paints and Coatings: Provide products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24) :
 - a. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
 - b. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
 - c. Anticorrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC content of not more than 250 g/L.
 - d. Flat Interior Topcoat Paints: VOC content of not more than 50 g/L.
 - e. Nonflat Interior Topcoat Paints: VOC content of not more than 150 g/L.

- f. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
- g. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
- h. Zinc-Rich Industrial Maintenance Primers: VOC content of not more than 340 g/L.
- 2. Chemical Components of Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
 - a. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing 1 or more benzene rings).
 - b. Restricted Components: Paints and coatings shall not contain any of the following:
 - 1) Acrolein.
 - 2) Acrylonitrile.
 - 3) Antimony.
 - 4) Benzene.
 - 5) Butyl benzyl phthalate.
 - 6) Cadmium.
 - 7) Di (2-ethylhexyl) phthalate.
 - 8) Di-n-butyl phthalate.
 - 9) Di-n-octyl phthalate.
 - 10) 1,2-dichlorobenzene.
 - 11) Diethyl phthalate.
 - 12) Dimethyl phthalate.
 - 13) Ethylbenzene.
 - 14) Formaldehyde.
 - 15) Hexavalent chromium.
 - 16) Isophorone.
 - 17) Lead.
 - 18) Mercury.
 - 19) Methyl ethyl ketone.
 - 20) Methyl isobutyl ketone.
 - 21) Methylene chloride.
 - 22) Naphthalene.
 - 23) Toluene (methylbenzene).
 - 24) 1,1,1-trichloroethane.
 - 25) Vinyl chloride.
- 3. Colors: As selected from manufacturer's full range **OR** Match samples, **as directed**.
- 4. Primer: Undercoating recommended in writing for use in coating system by manufacturer of high-temperature-resistant coating under conditions indicated.
- 5. Heat-Resistant Enamel (Gloss): MPI #21.
 - a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
- 6. Inorganic Zinc Primer: MPI #19.
 - a. VOC Content: Minimum E Range of 0 **OR** E1 **OR** E2 **OR** E3, **as directed**.
- 7. Aluminum Heat-Resistant Enamel: MPI #2.
 - a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
- 8. High-Heat-Resistant Coating: MPI #22.
 - a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.

1.3 EXECUTION

A. Preparation

1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" **OR** "MPI Maintenance Repainting Manual," **as directed**, applicable to substrates indicated.
 2. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
 - a. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.
 3. Clean steel substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants.
 - a. Remove incompatible primers as required to produce coating systems indicated.
- B. Application
1. Apply high-temperature-resistant coating systems according to manufacturer's written instructions.
 - a. Use applicators and techniques suited for coating and substrate indicated.
 - b. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
 - c. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
- C. Field Quality Control
1. Contractor shall invoke the following procedure at any time and as often as necessary during the period when coatings are being applied:
 - a. Engage the services of a qualified testing agency to sample coating material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 - b. Testing agency will perform tests for compliance with specified requirements.
 - c. the Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.
- D. Cleaning And Protection
1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
 2. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
 3. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by the Owner, and leave in an undamaged condition.
 4. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.
- E. High-Temperature-Resistant Coating Schedule
1. Heat-Resistant Enamel (Gloss) Coating System (System below corresponds with MPI EXT 5.2A and MPI INT 5.2A coating systems) {suitable for use on surfaces that reach a maximum temperature of 400 deg F (205 deg C)}:
 - a. Surface Preparation: Clean using methods recommended in writing by finish-coat manufacturer, but not less than blast cleaning according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning **OR** SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning," **as directed**.
 - b. Prime Coat: Primer.

- c. Finish Coat(s): Heat-resistant enamel (gloss), MPI #21, in number of coats recommended in writing by manufacturer for conditions indicated.
2. Inorganic Zinc Primer Coating System (System below corresponds with MPI EXT 5.2C and MPI INT 5.2C coating systems) {suitable for use on surfaces that reach a maximum temperature of 750 deg F (400 deg C)}:
 - a. Surface Preparation: Clean using methods recommended in writing by finish-coat manufacturer, but not less than blast cleaning according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning **OR** SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning," **as directed**.
 - b. Prime Coat: Primer.
 - c. Finish Coat(s): Inorganic zinc primer, MPI #19, in number of coats recommended in writing by manufacturer for conditions indicated.
3. Aluminum Heat-Resistant Enamel Coating System (System below corresponds with MPI EXT 5.2B and MPI INT 5.2B coating systems) {suitable for use on surfaces that reach a maximum temperature of 800 deg F (427 deg C)}:
 - a. Surface Preparation: Clean using methods recommended in writing by finish-coat manufacturer, but not less than blast cleaning according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning **OR** SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning," **as directed**.
 - b. Prime Coat: Primer.
 - c. Finish Coat(s): Aluminum heat-resistant enamel, MPI #2, in number of coats recommended in writing by manufacturer for conditions indicated.
4. High-Heat-Resistant Coating System (System below corresponds with MPI EXT 5.2D and MPI INT 5.2D coating systems) {suitable for use on surfaces that reach a maximum temperature of 1100 deg F (593 deg C)}:
 - a. Surface Preparation: Clean using methods recommended in writing by finish-coat manufacturer, but not less than blast cleaning according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning **OR** SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning," **as directed**.
 - b. Prime Coat: Primer.
 - c. Finish Coat(s): High-heat-resistant coating, MPI #22, in number of coats recommended in writing by manufacturer for conditions indicated.

END OF SECTION 09 91 13 00a

SECTION 09 91 23 00 - INTERIOR PAINTING

1.1 GENERAL

A. Description Of Work

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

B. Summary

1. This Section includes surface preparation and the application of paint systems on the following interior substrates:
 - a. Concrete.
 - b. Clay masonry.
 - c. Concrete masonry units (CMU).
 - d. Steel.
 - e. Galvanized metal.
 - f. Aluminum (not anodized or otherwise coated).
 - g. Wood.
 - h. Gypsum board.
 - i. Plaster.
 - j. Spray-textured ceilings.
 - k. Cotton or canvas insulation covering.

C. Submittals

1. Product Data: For each type of product indicated.
2. Samples: For each finish and for each color and texture required.
3. Product List: Printout of current "MPI Approved Products List" for each product category specified in Part 1.2, with the proposed product highlighted.
4. LEED Submittal:
 - a. Product Data for Credit EQ 4.2: For paints, including printed statement of VOC content and chemical components.

D. Quality Assurance

1. MPI Standards:
 - a. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
 - b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.
2. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - a. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - 1) Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
 - 2) Other Items: Architect will designate items or areas required.
 - b. Final approval of color selections will be based on mockups.
 - 1) If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
 - c. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

- d. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Delivery, Storage, And Handling

- 1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **45 deg F (7 deg C)**.
 - a. Maintain containers in clean condition, free of foreign materials and residue.
 - b. Remove rags and waste from storage areas daily.

F. Project Conditions

- 1. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between **50 and 95 deg F (10 and 35 deg C)**.
- 2. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than **5 deg F (3 deg C)** above the dew point; or to damp or wet surfaces.

1.2 PRODUCTS

A. Paint, General

- 1. Material Compatibility:
 - a. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - b. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- 2. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
 - a. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
 - b. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
 - c. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
 - d. Floor Coatings: VOC not more than 100 g/L.
 - e. Shellacs, Clear: VOC not more than 730 g/L.
 - f. Shellacs, Pigmented: VOC not more than 550 g/L.
 - g. Flat Topcoat Paints: VOC content of not more than 50 g/L.
 - h. Nonflat Topcoat Paints: VOC content of not more than 150 g/L.
 - i. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
 - j. Floor Coatings: VOC not more than 100 g/L.
 - k. Shellacs, Clear: VOC not more than 730 g/L.
 - l. Shellacs, Pigmented: VOC not more than 550 g/L.
 - m. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
 - n. Dry-Fog Coatings: VOC content of not more than 400 g/L.
 - o. Zinc-Rich Industrial Maintenance Primers: VOC content of not more than 340 g/L.
 - p. Pre-Treatment Wash Primers: VOC content of not more than 420 g/L.
- 3. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
 - a. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
 - b. Restricted Components: Paints and coatings shall not contain any of the following:

- 1) Acrolein.
 - 2) Acrylonitrile.
 - 3) Antimony.
 - 4) Benzene.
 - 5) Butyl benzyl phthalate.
 - 6) Cadmium.
 - 7) Di (2-ethylhexyl) phthalate.
 - 8) Di-n-butyl phthalate.
 - 9) Di-n-octyl phthalate.
 - 10) 1,2-dichlorobenzene.
 - 11) Diethyl phthalate.
 - 12) Dimethyl phthalate.
 - 13) Ethylbenzene.
 - 14) Formaldehyde.
 - 15) Hexavalent chromium.
 - 16) Isophorone.
 - 17) Lead.
 - 18) Mercury.
 - 19) Methyl ethyl ketone.
 - 20) Methyl isobutyl ketone.
 - 21) Methylene chloride.
 - 22) Naphthalene.
 - 23) Toluene (methylbenzene).
 - 24) 1,1,1-trichloroethane.
 - 25) Vinyl chloride.
4. Colors: As selected from manufacturer's full range **OR** Match samples **OR** As indicated in a color schedule, **as directed**.
- B. Block Fillers
1. Interior/Exterior Latex Block Filler: MPI #4.
 - a. VOC Content: E Range of E2 **OR** E3, **as directed**.
- C. Primers/Sealers
1. Interior Latex Primer/Sealer: MPI #50.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
 2. Interior Alkyd Primer/Sealer: MPI #45.
 - a. VOC Content: E Range of E1 **OR** E2, **as directed**.
 3. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for use in paint systems indicated.
- D. Metal Primers
1. Alkyd Anticorrosive Metal Primer: MPI #79.
 - a. VOC Content: E Range of E1 **OR** E2, **as directed**.
 2. Quick-Drying Alkyd Metal Primer: MPI #76.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 3. Rust-Inhibitive Primer (Water Based): MPI #107.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
 4. Cementitious Galvanized-Metal Primer: MPI #26.
 - a. VOC Content: E Range of E1.
 5. Waterborne Galvanized-Metal Primer: MPI #134.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
 6. Vinyl Wash Primer: MPI #80.
 - a. VOC Content: E Range of E2 **OR** E3, **as directed**.

7. Quick-Drying Primer for Aluminum: MPI #95.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

E. Wood Primers

1. Interior Latex-Based Wood Primer: MPI #39.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.

F. Latex Paints

1. Interior Latex (Flat): MPI #53 (Gloss Level 1).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 0.5 **OR** EPR 1.5 **OR** EPR 2.5, **as directed**.
2. Interior Latex (Low Sheen): MPI #44 (Gloss Level 2).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
3. Interior Latex (Eggshell): MPI #52 (Gloss Level 3).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
4. Interior Latex (Satin): MPI #43 (Gloss Level 4).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 1.5 **OR** EPR 2 **OR** EPR 2.5 **OR** EPR 3.5, **as directed**.
5. Interior Latex (Semigloss): MPI #54 (Gloss Level 5).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 2 **OR** EPR 3 **OR** EPR 4, **as directed**.
6. Interior Latex (Gloss): MPI #114 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 2 **OR** EPR 3 **OR** EPR 4, **as directed**.
7. Institutional Low-Odor/VOC Latex (Flat): MPI #143 (Gloss Level 1).
 - a. VOC Content: E Range of E3.
 - b. Environmental Performance Rating: EPR 4 **OR** EPR 5.5, **as directed**.
8. Institutional Low-Odor/VOC Latex (Low Sheen): MPI #144 (Gloss Level 2).
 - a. VOC Content: E Range of E3.
 - b. Environmental Performance Rating: EPR 4.5.
9. Institutional Low-Odor/VOC Latex (Eggshell): MPI #145 (Gloss Level 3).
 - a. VOC Content: E Range of E3.
 - b. Environmental Performance Rating: EPR 4.5.
10. Institutional Low-Odor/VOC Latex (Semigloss): MPI #147 (Gloss Level 5).
 - a. VOC Content: E Range of E3.
 - b. Environmental Performance Rating: EPR 3 **OR** EPR 5.5, **as directed**.
11. High-Performance Architectural Latex (Low Sheen): MPI #138 (Gloss Level 2).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 4 **OR** EPR 5 **OR** EPR 6, **as directed**.
12. High-Performance Architectural Latex (Eggshell): MPI #139 (Gloss Level 3).
 - a. VOC Content: E Range of E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 5 **OR** EPR 6, **as directed**.
13. High-Performance Architectural Latex (Satin): MPI #140 (Gloss Level 4).
 - a. VOC Content: E Range of E1 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 4.5 **OR** EPR 6.5, **as directed**.
14. High-Performance Architectural Latex (Semigloss): MPI #141 (Gloss Level 5).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 5 **OR** EPR 6 **OR** EPR 7, **as directed**.
15. Exterior Latex (Flat): MPI #10 (Gloss Level 1).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
16. Exterior Latex (Semigloss): MPI #11 (Gloss Level 5).

- a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
- 17. Exterior Latex (Gloss): MPI #119 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
- G. Alkyd Paints
 - 1. Interior Alkyd (Flat): MPI #49 (Gloss Level 1).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - 2. Interior Alkyd (Eggshell): MPI #51 (Gloss Level 3).
 - a. VOC Content: E Range of E1 **OR** E2, **as directed**.
 - 3. Interior Alkyd (Semigloss): MPI #47 (Gloss Level 5).
 - a. VOC Content: E Range of E1 **OR** E2, **as directed**.
 - b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
 - 4. Interior Alkyd (Gloss): MPI #48 (Gloss Level 6).
 - a. VOC Content: E Range of E1 **OR** E2, **as directed**.
- H. Quick-Drying Enamels
 - 1. Quick-Drying Enamel (Semigloss): MPI #81 (Gloss Level 5).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - 2. Quick-Drying Enamel (High Gloss): MPI #96 (Gloss Level 7).
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
- I. Textured Coating
 - 1. Latex Stucco and Masonry Textured Coating: MPI #42.
 - a. VOC Content: E Range of E2 **OR** E3, **as directed**.
- J. Dry Fog/Fall Coatings
 - 1. Latex Dry Fog/Fall: MPI #118.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
 - 2. Waterborne Dry Fall: MPI #133.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
 - 3. Interior Alkyd Dry Fog/Fall: MPI #55.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
- K. Aluminum Paint
 - 1. Aluminum Paint: MPI #1.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
- L. Floor Coatings
 - 1. Interior Concrete Floor Stain: MPI #58.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 2.
 - 2. Interior/Exterior Clear Concrete Floor Sealer (Water Based): MPI #99.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - 3. Interior/Exterior Clear Concrete Floor Sealer (Solvent Based): MPI #104.
 - a. VOC Content: E Range of E1 **OR** E2, **as directed**.
 - 4. Interior/Exterior Latex Floor and Porch Paint (Low Gloss): MPI #60 (maximum Gloss Level 3).
 - a. VOC Content: E Range of E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 3.
 - 5. Exterior/Interior Alkyd Floor Enamel (Gloss): MPI #27 (Gloss Level 6).
 - a. VOC Content: E Range of E1 **OR** E2, **as directed**.
 - b. Additives: Manufacturer's standard additive to increase skid resistance of painted surface.

1.3 EXECUTION

A. Preparation

1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
2. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - a. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
 - b. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
3. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
 - a. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
4. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
5. Clay Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content of surfaces or alkalinity of mortar joints to be painted exceed that permitted in manufacturer's written instructions.
6. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
7. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.
8. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
9. Aluminum Substrates: Remove surface oxidation.
10. Wood Substrates:
 - a. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - b. Sand surfaces that will be exposed to view, and dust off.
 - c. Prime edges, ends, faces, undersides, and backsides of wood.
 - d. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
11. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.
12. Plaster Substrates: Do not begin paint application until plaster is fully cured and dry.
13. Spray-Textured Ceiling Substrates: Do not begin paint application until surfaces are dry.
14. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

B. Application

1. Apply paints according to manufacturer's written instructions.
 - a. Use applicators and techniques suited for paint and substrate indicated.
 - b. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - c. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
2. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

3. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
 4. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
 5. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
 - a. Mechanical Work:
 - 1) Uninsulated metal piping.
 - 2) Uninsulated plastic piping.
 - 3) Pipe hangers and supports.
 - 4) Tanks that do not have factory-applied final finishes.
 - 5) Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
 - 6) Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - 7) Mechanical equipment that is indicated to have a factory-primed finish for field painting.
 - b. Electrical Work:
 - 1) Switchgear.
 - 2) Panelboards.
 - 3) Electrical equipment that is indicated to have a factory-primed finish for field painting.
- C. Field Quality Control
1. Testing of Paint Materials: The following procedure may be requested at any time and as often as the Owner deems necessary during the period when paints are being applied:
 - a. Engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 - b. Testing agency will perform tests for compliance with product requirements.
 - c. the Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.
- D. Cleaning And Protection
1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
 2. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
 3. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by the Owner, and leave in an undamaged condition.
 4. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.
- E. Interior Painting Schedule
1. Concrete Substrates, Nontraffic Surfaces:
 - a. Latex System: MPI INT 3.1E.
 - 1) Prime Coat: Interior latex matching topcoat.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Latex Over Sealer System: MPI INT 3.1A.

- 1) Prime Coat: Interior latex primer/sealer.
- 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
- 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
- c. Latex Over Latex Aggregate System: MPI INT 3.1B.
 - 1) Prime Coat: Latex stucco and masonry textured coating.
 - 2) Intermediate Coat (for MPI Premium Grade system): Exterior latex matching topcoat.
 - 3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
- d. Alkyd System: MPI INT 3.1D.
 - 1) Prime Coat: Interior latex primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
 - 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
- e. Institutional Low-Odor/VOC Latex System: MPI INT 3.1M.
 - 1) Prime Coat: Institutional low-odor/VOC interior latex matching topcoat.
 - 2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
 - 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
- f. High-Performance Architectural Latex System: MPI INT 3.1C.
 - 1) Prime Coat: Interior latex primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
 - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
2. Concrete Substrates, Traffic Surfaces:
 - a. Latex Floor Enamel System: MPI INT 3.2A.
 - 1) Prime Coat: Interior/exterior latex floor and porch paint (low gloss).
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior/exterior latex floor and porch paint (low gloss).
 - 3) Topcoat: Interior/exterior latex floor and porch paint (low gloss).
 - b. Alkyd Floor Enamel System: MPI INT 3.2B.
 - 1) Prime Coat: Exterior/interior alkyd floor enamel (gloss).
 - 2) Intermediate Coat (for MPI Premium Grade system): Exterior/interior alkyd floor enamel (gloss).
 - 3) Topcoat: Exterior/interior alkyd floor enamel (gloss).
 - c. Concrete Stain System: MPI INT 3.2E.
 - 1) First Coat (for MPI Premium Grade system): Interior concrete floor stain.
 - 2) Topcoat: Interior concrete floor stain.
 - d. Clear Sealer System: MPI INT 3.2F.
 - 1) First Coat: Interior/exterior clear concrete floor sealer (solvent based).
 - 2) Topcoat: Interior/exterior clear concrete floor sealer (solvent based).
 - e. Water-Based Clear Sealer System: MPI INT 3.2G.
 - 1) First Coat: Interior/exterior clear concrete floor sealer (water based).
 - 2) Topcoat: Interior/exterior clear concrete floor sealer (water based).
3. Clay-Masonry Substrates:
 - a. Latex System: MPI INT 4.1A.
 - 1) Prime Coat: Interior latex matching topcoat.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Alkyd System: MPI INT 4.1D.
 - 1) Prime Coat: Interior latex primer/sealer.

- 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
- 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
- c. Latex Aggregate System: MPI INT 4.1B.
 - 1) Prime Coat: As recommended in writing by topcoat manufacturer.
 - 2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
 - 3) Topcoat: Latex stucco and masonry textured coating.
- d. Institutional Low-Odor/VOC Latex System: MPI INT 4.1M.
 - 1) Prime Coat: Institutional low-odor/VOC interior latex matching topcoat.
 - 2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
 - 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
- e. High-Performance Architectural Latex System: MPI INT 4.1L.
 - 1) Prime Coat: High-performance architectural latex matching topcoat.
 - 2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
 - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
4. CMU Substrates:
 - a. Latex System: MPI INT 4.2A.
 - 1) Prime Coat: Interior/exterior latex block filler.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Alkyd System: MPI INT 4.2C.
 - 1) Prime Coat: Interior/exterior latex block filler.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
 - 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Alkyd Over Latex Sealer System: MPI INT 4.2N.
 - 1) Prime Coat: Interior/exterior latex block filler.
 - 2) Sealer Coat: Interior latex primer/sealer.
 - 3) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
 - 4) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
 - d. Institutional Low-Odor/VOC Latex System: MPI INT 4.2E.
 - 1) Prime Coat: Interior/exterior latex block filler.
 - 2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
 - 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
 - e. High-Performance Architectural Latex System: MPI INT 4.2D.
 - 1) Prime Coat: Interior/exterior latex block filler.
 - 2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
 - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
5. Steel Substrates:
 - a. Quick-Drying Enamel System: MPI INT 5.1A.
 - 1) Prime Coat: Quick-drying alkyd metal primer.
 - 2) Intermediate Coat: Quick-drying enamel matching topcoat.
 - 3) Topcoat: Quick-drying enamel (semigloss) **OR** (high gloss), **as directed**.
 - b. Water-Based Dry-Fall System: MPI INT 5.1C.
 - 1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
 - 2) Topcoat: Latex dry fog/fall **OR** Waterborne dry fall, **as directed**.

- c. Alkyd Dry-Fall System: MPI INT 5.1D.
 - 1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
 - 2) Topcoat: Interior alkyd dry fog/fall.
- d. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - 1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
- e. Alkyd System: MPI INT 5.1E.
 - 1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
 - 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
- f. Aluminum Paint System: MPI INT 5.1M.
 - 1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.
 - 3) Topcoat: Aluminum paint.
- g. Institutional Low-Odor/VOC Latex System: MPI INT 5.1S.
 - 1) Prime Coat: Rust-inhibitive primer (water based).
 - 2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
 - 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
- h. High-Performance Architectural Latex System: MPI INT 5.1R.
 - 1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
 - 2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
 - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
- 6. Galvanized-Metal Substrates:
 - a. Water-Based Dry-Fall System: MPI INT 5.3H.
 - 1) Prime Coat: Waterborne dry fall.
 - 2) Topcoat: Waterborne dry fall.
 - b. Alkyd Dry-Fall System: MPI INT 5.3F.
 - 1) Prime Coat: Cementitious galvanized-metal primer.
 - 2) Topcoat: Interior alkyd dry fog/fall.
 - c. Latex System: MPI INT 5.3A.
 - 1) Prime Coat: Cementitious galvanized-metal primer.
 - 2) Intermediate Coat: Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
 - d. Latex Over Waterborne Primer System: MPI INT 5.3J.
 - 1) Prime Coat: Waterborne galvanized-metal primer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
 - e. Alkyd System: MPI INT 5.3C.
 - 1) Prime Coat: Cementitious galvanized-metal primer.
 - 2) Intermediate Coat: Interior alkyd matching topcoat.
 - 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
 - f. Aluminum Paint System: MPI INT 5.3G.
 - 1) Prime Coat: Cementitious galvanized-metal primer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.
 - 3) Topcoat: Aluminum paint.
 - g. Institutional Low-Odor/VOC Latex System: MPI INT 5.3N.

- 1) Prime Coat: Waterborne galvanized-metal primer.
- 2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
- 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
- h. High-Performance Architectural Latex System: MPI INT 5.3M.
 - 1) Prime Coat: Waterborne galvanized-metal primer.
 - 2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
 - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
7. Aluminum (Not Anodized or Otherwise Coated) Substrates:
 - a. Latex System: MPI INT 5.4H.
 - 1) Prime Coat: Quick-drying primer for aluminum.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Alkyd Over Vinyl Wash Primer System: MPI INT 5.4A.
 - 1) Prime Coat: Vinyl wash primer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
 - 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Alkyd Over Quick-Drying Primer System: MPI INT 5.4J.
 - 1) Prime Coat: Quick-drying primer for aluminum.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
 - 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
 - d. Aluminum Paint System: MPI INT 5.4D.
 - 1) Prime Coat: Vinyl wash primer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.
 - 3) Topcoat: Aluminum paint.
 - e. Institutional Low-Odor/VOC Latex System: MPI INT 5.4G.
 - 1) Prime Coat: Quick-drying primer for aluminum.
 - 2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
 - 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
 - f. High-Performance Architectural Latex System: MPI INT 5.4F.
 - 1) Prime Coat: Quick-drying primer for aluminum.
 - 2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
 - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
8. Glue-Laminated Beam and Column Substrates:
 - a. Latex System: MPI INT 6.1M.
 - 1) Prime Coat: Interior latex-based wood primer.
 - 2) Intermediate Coat: Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Latex Over Alkyd Primer System: MPI INT 6.1A.
 - 1) Prime Coat: Interior alkyd primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Alkyd System: MPI INT 6.1B.
 - 1) Prime Coat: Interior alkyd primer/sealer.

- 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
- 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
- d. Institutional Low-Odor/VOC Latex System: MPI INT 6.1Q.
 - 1) Prime Coat: Interior latex-based wood primer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
 - 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
- e. High-Performance Architectural Latex System: MPI INT 6.1N.
 - 1) Prime Coat: Interior latex-based wood primer.
 - 2) Intermediate Coat: High-performance architectural latex matching topcoat.
 - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
9. Dressed Lumber Substrates: Including architectural woodwork and doors.
 - a. Latex System: MPI INT 6.3T.
 - 1) Prime Coat: Interior latex-based wood primer.
 - 2) Intermediate Coat: Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (semigloss) **OR** (gloss), **as directed**.
 - b. Latex Over Alkyd Primer System: MPI INT 6.3U.
 - 1) Prime Coat: Interior alkyd primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (semigloss) **OR** (gloss), **as directed**.
 - c. Alkyd System: MPI INT 6.3B.
 - 1) Prime Coat: Interior alkyd primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
 - 3) Topcoat: Interior alkyd (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
 - d. Institutional Low-Odor/VOC Latex System: MPI INT 6.3V.
 - 1) Prime Coat: Interior latex-based wood primer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
 - 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
 - e. High-Performance Architectural Latex System: MPI INT 6.3A.
 - 1) Prime Coat: Interior latex-based wood primer.
 - 2) Intermediate Coat: High-performance architectural latex matching topcoat.
 - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
10. Wood Panel Substrates: Including painted plywood, medium-density fiberboard, and hardboard.
 - a. Latex System: MPI INT 6.4R.
 - 1) Prime Coat: Interior latex-based wood primer.
 - 2) Intermediate Coat: Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (semigloss) **OR** (gloss), **as directed**.
 - b. Latex Over Alkyd Primer System: MPI INT 6.4A.
 - 1) Prime Coat: Interior alkyd primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Alkyd System: MPI INT 6.4B.
 - 1) Prime Coat: Interior alkyd primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
 - 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
 - d. Institutional Low-Odor/VOC Latex System: MPI INT 6.4T.

- 1) Prime Coat: Interior latex-based wood primer.
- 2) Intermediate Coat : Institutional low-odor/VOC interior latex matching topcoat.
- 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
- e. High-Performance Architectural Latex System: MPI INT 6.4S.
 - 1) Prime Coat: Interior latex-based wood primer.
 - 2) Intermediate Coat: High-performance architectural latex matching topcoat.
 - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
11. Dimension Lumber Substrates, Nontraffic Surfaces: Including exposed joists and exposed beams.
 - a. Latex System: MPI INT 6.2D.
 - 1) Prime Coat: Interior latex-based wood primer.
 - 2) Intermediate Coat: Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Latex Over Alkyd Primer System: MPI INT 6.2A.
 - 1) Prime Coat: Interior alkyd primer/sealer.
 - 2) Intermediate Coat : Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Alkyd System: MPI INT 6.2C.
 - 1) Prime Coat: Interior alkyd primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
 - 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
 - d. Institutional Low-Odor/VOC Latex System: MPI INT 6.2L.
 - 1) Prime Coat: Interior latex-based wood primer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
 - 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
 - e. High-Performance Architectural Latex System: MPI INT 6.2B.
 - 1) Prime Coat: Interior alkyd primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
 - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
12. Wood Substrates, Traffic Surfaces:
 - a. Latex Floor Paint System: MPI INT 6.5G.
 - 1) Prime Coat: Interior alkyd primer/sealer.
 - 2) Intermediate Coat: Interior/exterior latex floor and porch paint (low gloss).
 - 3) Topcoat: Interior/exterior latex floor and porch paint (low gloss).
 - b. Alkyd Floor Enamel System: MPI INT 6.5A.
 - 1) Prime Coat: Exterior/interior alkyd floor enamel (gloss).
 - 2) Intermediate Coat: Exterior/interior alkyd floor enamel (gloss).
 - 3) Topcoat: Exterior/interior alkyd floor enamel (gloss).
13. Gypsum Board Substrates:
 - a. Latex System: MPI INT 9.2A.
 - 1) Prime Coat: Interior latex primer/sealer (for MPI Premium Grade system) **OR** matching topcoat, **as directed**.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Alkyd Over Latex Primer System: MPI INT 9.2C.
 - 1) Prime Coat: Interior latex primer/sealer.

- 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
 - 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M.
 - 1) Prime Coat: Interior latex primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
 - 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
 - d. High-Performance Architectural Latex System: MPI INT 9.2B.
 - 1) Prime Coat: Interior latex primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
 - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
14. Plaster Substrates:
- a. Latex System: MPI INT 9.2A.
 - 1) Prime Coat: Interior latex primer/sealer (for MPI Premium Grade system) **OR** matching topcoat, **as directed**.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Latex Over Alkyd Primer System: MPI INT 9.2K.
 - 1) Prime Coat: Interior alkyd primer/sealer.
 - 2) Intermediate Coat: Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Alkyd Over Latex Primer System: MPI INT 9.2C.
 - 1) Prime Coat: Interior latex primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
 - 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
 - d. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M.
 - 1) Prime Coat: Interior latex primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
 - 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
 - e. High-Performance Architectural Latex System: MPI INT 9.2B.
 - 1) Prime Coat: Interior latex primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
 - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
15. Spray-Textured Ceiling Substrates:
- a. Latex (Flat) System: MPI INT 9.1A, spray applied.
 - 1) Prime Coat: Interior latex primer/sealer **OR** (flat), **as directed**.
 - 2) Topcoat: Interior latex (flat).
 - b. Latex System: MPI INT 9.1E, spray applied.
 - 1) Prime Coat: Interior latex matching topcoat.
 - 2) Intermediate Coat: Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
 - c. Latex Over Alkyd Primer System: MPI INT 9.1B.
 - 1) Prime Coat: Interior alkyd primer/sealer.

- 2) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
 - d. Alkyd (Flat) System: MPI INT 9.1C.
 - 1) Prime Coat: Interior alkyd (flat).
 - 2) Topcoat: Interior alkyd (flat).
 - e. Alkyd System: MPI INT 9.1D.
 - 1) Prime Coat: Interior alkyd primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
 - 3) Topcoat: Interior alkyd (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
- 16. Cotton or Canvas Insulation-Covering Substrates: Including pipe and duct coverings.
 - a. Latex System: MPI INT 10.1A.
 - 1) Prime Coat: Interior latex primer/sealer (for MPI Premium Grade system) **OR** matching topcoat, **as directed**.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
 - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Alkyd Over Latex Primer System: MPI INT 10.1B.
 - 1) Prime Coat: Interior latex primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
 - 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Aluminum Paint System: MPI INT 10.1C.
 - 1) Prime Coat: Interior latex primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.
 - 3) Topcoat: Aluminum paint.
 - d. Institutional Low-Odor/VOC Latex System: MPI INT 10.1D.
 - 1) Prime Coat: Interior latex primer/sealer.
 - 2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
 - 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

END OF SECTION 09 91 23 00

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SECTION 09 91 23 00a - MULTICOLORED INTERIOR COATINGS

1.1 GENERAL

A. Description Of Work

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

B. Summary

1. This Section includes surface preparation and field application of multicolor interior coating systems applied on the following substrates:
 - a. Vertical concrete.
 - b. Cementitious composition board.
 - c. Clay masonry units.
 - d. Concrete masonry units (CMU).
 - e. Wood.
 - f. Fiberglass moldings and trim.
 - g. Plastic moldings and trim.
 - h. Plaster, Gypsum veneer plaster, and Gypsum board.

C. Submittals

1. Product Data: For each type of product indicated.
2. Samples: For each finish-coat product and for each color and texture required.
3. LEED Submittal:
 - a. Product Data for Credit EQ 4.2: For coatings, including printed statement of VOC content and chemical components.

D. Quality Assurance

1. Fire-Test-Response Characteristics: Provide coatings with flame-spread and smoked-developed indexes of 25 or less and 450 or less, respectively, as determined by testing identical products per ASTM E 84 by testing and inspecting agency acceptable to authorities having jurisdiction.
2. Master Painters Institute (MPI) Standards: Comply with recommendations in "MPI Architectural Painting Specification Manual" **OR** "MPI Maintenance Repainting Manual," **as directed**, applicable to products and coating systems indicated.
3. Mockups: Apply mockup of each coating system indicated to verify preliminary selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - a. Architect will select one surface to represent surfaces and conditions for application of each coating system and type of substrate.
 - 1) Wall Surfaces: Provide samples of at least **100 sq. ft. (9 sq. m)**.
 - 2) Other Items: Architect will designate items or areas required.
 - b. Apply mockup after permanent lighting and other environmental services have been activated.
 - c. Final approval of color and pattern selections will be based on mockup.
 - 1) If preliminary color and pattern selections are not approved, apply additional mockups of colors and patterns selected by Architect at no added cost to Owner.
 - d. Repair Mockup: After approval of color and pattern selections, apply representative repairs to **100 sq. in. (65 sq. cm)** of mockup to establish quality standards for coating system repairs.
 - e. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

- f. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Delivery, Storage, And Handling

1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **45 deg F (7 deg C)**.
 - a. Maintain containers in clean condition, free of foreign materials and residue.
 - b. Remove rags and waste from storage areas daily.

1.2 PRODUCTS

A. Multicolor Coating Systems, General

1. Material Compatibility: Provide materials for use within each coating system that are compatible with one another and substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
2. VOC Content of Interior Paints and Coatings: Provide products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - a. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
 - b. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
 - c. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
 - d. Shellacs, Clear: VOC not more than 730 g/L.
 - e. Shellacs, Pigmented: VOC not more than 550 g/L.
 - f. Flat Topcoat Paints: VOC content of not more than 50 g/L.
 - g. Nonflat Topcoat Paints: VOC content of not more than 150 g/L.
 - h. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
 - i. Shellacs, Clear: VOC not more than 730 g/L.
 - j. Shellacs, Pigmented: VOC not more than 550 g/L.
 - k. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
3. Chemical Components of Interior Paints and Coatings: Provide topcoat paints that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
 - a. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing 1 or more benzene rings).
 - b. Restricted Components: Paints and coatings shall not contain any of the following:
 - 1) Acrolein.
 - 2) Acrylonitrile.
 - 3) Antimony.
 - 4) Benzene.
 - 5) Butyl benzyl phthalate.
 - 6) Cadmium.
 - 7) Di (2-ethylhexyl) phthalate.
 - 8) Di-n-butyl phthalate.
 - 9) Di-n-octyl phthalate.
 - 10) 1,2-dichlorobenzene.
 - 11) Diethyl phthalate.
 - 12) Dimethyl phthalate.
 - 13) Ethylbenzene.
 - 14) Formaldehyde.
 - 15) Hexavalent chromium.
 - 16) Isophorone.
 - 17) Lead.
 - 18) Mercury.
 - 19) Methyl ethyl ketone.

- 20) Methyl isobutyl ketone.
 - 21) Methylene chloride.
 - 22) Naphthalene.
 - 23) Toluene (methylbenzene).
 - 24) 1,1,1-trichloroethane.
 - 25) Vinyl chloride.
4. Colors and Patterns: Match samples **OR** As selected from manufacturer's full range **OR** As indicated in color schedule, **as directed**.

B. Fillers And Primers

1. General: Undercoatings recommended in writing for use in coating systems by manufacturer of multicolor interior coating on substrates and under conditions indicated.
2. Latex Block Filler: Waterborne, high-solids, emulsion-type, pigmented coating product recommended in writing for use in coating system indicated by manufacturer of multicolor interior coating, with bridging and filling properties, and formulated for filling surfaces of CMU for subsequent applications of finish coatings.
 - a. VOC Content: Minimum E Range of E2 **OR** E3, **as directed**, according to requirements for MPI #4.
3. Wood Filler Paste: Solvent-based, high-solids, clear paste product recommended in writing for use in coating system indicated by manufacturer of multicolor interior coating, for use on open-grained or damaged woods and that fills hardwood pores with minimal surface residues and without showing cracking or shrinkage. When dry, sanding filler produces a smooth surface without clogging or gumming sandpaper.
 - a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**, according to requirements for MPI #91.
4. Wood-Knot Sealer: White shellac or other sealer recommended in writing for this purpose by manufacturer of multicolor interior coating.
5. Primer/Sealer for Multicolor Systems: Acrylic or acrylic/polyvinyl acetate (PVA) co-polymer emulsion-type, pigmented primer/sealer product recommended in writing for use in coating system indicated by manufacturer of multicolor interior coating.
 - a. VOC Content: Minimum E Range of E2 **OR** E3, **as directed**, according to requirements for MPI #125.
6. Interior Alkyd Primer/Sealer: Solvent-based, pigmented primer/sealer.
 - a. VOC Content: Minimum E Range of E1 **OR** E2, **as directed**, according to requirements for MPI #45.
7. Water-Based Bonding Primer: Water-based, emulsion-type, pigmented primer product recommended in writing for use in coating system indicated by manufacturer of multicolor interior coating, and formulated to promote adhesion of subsequent coatings.
 - a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**, according to requirements for MPI #17.
8. Solvent-Based Bonding Primer: Solvent-based, pigmented product recommended in writing for use in coating system indicated by manufacturer of multicolor interior coating, and formulated to promote adhesion of subsequent coatings to substrate.
 - a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**, according to requirements for MPI #69.

C. Multicolor Coatings

1. Multicolor Coatings: Complying with MPI #112 and listed in "MPI Approved Products List."
 - a. VOC Content: Minimum E Range of E1 **OR** E3, **as directed**.
2. Clear Topcoat: Product of multicolor coating manufacturer complying with MPI #121 and listed in "MPI Approved Products List."
 - a. VOC Content: Minimum E Range of E1 **OR** E2, **as directed**.

1.3 EXECUTION

A. Preparation

1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
2. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
 - a. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.
3. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible primers, paints, and encapsulants.
4. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
5. Clay Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
6. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
7. Wood Substrates:
 - a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of knot sealer before applying primer.
 - b. Sand surfaces that will be exposed to view and dust off.
 - c. Prime edges, ends, faces, undersides, and back sides of wood.
 - d. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

B. Application

1. Apply coatings according to manufacturer's written instructions using applicators and techniques suited for coating and substrate indicated.
2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Apply coating systems to produce uniformly textured, colored, and patterned finished-surface films without substrates, undercoats, marks, or stains showing through. Produce sharp, even glass lines and color breaks.

C. Cleaning And Protection

1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
2. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
3. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by the Owner, and leave in an undamaged condition.
4. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

D. Multicolor Interior Coating Schedule

1. Vertical Concrete Substrates: System below corresponds to MPI INT 3.1H
 - a. Prime Coat: Primer/sealer for multicolor systems.

- b. Multicolor Base Coat: Multicolor coating, MPI #112.
 - c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
 - d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
2. Cementitious Composition Board Substrates: System below corresponds to MPI INT 3.3F
 - a. Prime Coat: Primer/sealer for multicolor systems.
 - b. Multicolor Base Coat: Multicolor coating, MPI #112.
 - c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
 - d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
3. Clay Masonry Units Substrates: System below corresponds to MPI INT 4.1H
 - a. Prime Coat: Primer/sealer for multicolor systems tinted to match multicolor basecoat.
 - b. Multicolor Base Coat: Multicolor coating, MPI #112.
 - c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
 - d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
4. CMU Substrates: System below corresponds to MPI INT 4.2H
 - a. Block Filler: Latex block filler.
 - b. Prime Coat: Primer/sealer for multicolor systems.
 - c. Multicolor Base Coat: Multicolor coating, MPI #112.
 - d. Multicolor Pattern Coat: Multicolor coating, MPI #112.
 - e. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
5. Wood Substrates: System below corresponds to MPI INT 6.2E, MPI INT 6.3N, and MPI INT 6.4L
 - a. Fill Coat: Wood filler paste (Fill coat is optional component and is for use on open-grained woods where a smooth, glasslike finish is desired).
 - b. Prime Coat: Interior alkyd primer/sealer tinted to match multicolor base coat (for dressed lumber (finished carpentry)).
 - c. Multicolor Base Coat: Multicolor coating, MPI #112.
 - d. Multicolor Pattern Coat: Multicolor coating, MPI #112.
 - e. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
6. Fiberglass Molding and Trim Substrates: System below corresponds to MPI INT 6.7G
 - a. Prime Coat: Water-based **OR** Solvent-based, **as directed**, bonding primer.
 - b. Multicolor Base Coat: Multicolor coating, MPI #112.
 - c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
 - d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
7. Plastic Molding and Trim Substrates: System below corresponds to MPI INT 6.8D
 - a. Prime Coat: Solvent-based bonding primer.
 - b. Multicolor Base Coat: Multicolor coating, MPI #112.
 - c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
 - d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
8. Plaster **OR** Gypsum Veneer Plaster **OR** Gypsum Board, **as directed**, Substrates: System below corresponds to MPI INT 9.2G
 - a. Prime Coat: Primer/sealer for multicolor systems.
 - b. Multicolor Base Coat: Multicolor coating, MPI #112.
 - c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
 - d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.

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Task	Specification	Specification Description
09 91 23 00	09 91 13 00	Exterior Painting

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SECTION 09 91 33 00 - WOOD STAINS AND TRANSPARENT FINISHES

1.1 GENERAL

A. Description Of Work

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

B. Summary

1. This Section includes surface preparation and the application of wood finishes on the following substrates:
 - a. Exterior Substrates:
 - 1) Exposed glue-laminated beams and columns.
 - 2) Exposed dimension lumber (rough carpentry).
 - 3) Dressed lumber (finish carpentry).
 - 4) Exposed wood panel products.
 - 5) Wood decks and stairs.
 - 6) Wood shingles and shakes (excluding roofs).
 - b. Interior Substrates:
 - 1) Exposed glue-laminated beams and columns.
 - 2) Exposed dimension lumber (rough carpentry).
 - 3) Dressed lumber (finish carpentry).
 - 4) Exposed wood panel products.

C. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittal:
 - a. Product Data for Credit EQ 4.2: For interior primers, stains, and transparent finishes, including printed statement of VOC content.
3. Samples: For each finish and for each color and texture required.
4. Product List: Printout of MPI's current "MPI Approved Products List" for each product category specified in Part 1.2, with the product proposed for use highlighted.

D. Quality Assurance

1. MPI Standards:
 - a. Products: Complying with MPI standards indicated and listed in its "MPI Approved Products List."
 - b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and finish systems indicated.

E. Delivery, Storage, And Handling

1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than **45 deg F (7 deg C)**.
 - a. Maintain containers in clean condition, free of foreign materials and residue.
 - b. Remove rags and waste from storage areas daily.

F. Project Conditions

1. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between **50 and 95 deg F (10 and 35 deg C)**.
2. Do not apply exterior finishes in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than **5 deg F (3 deg C)** above the dew point; or to damp or wet surfaces.

1.2 PRODUCTS

A. Materials, General

1. Material Compatibility:
 - a. Provide materials for use within each finish system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - b. For each coat in a finish system, provide products recommended in writing by manufacturers of topcoat for use in finish system and on substrate indicated.
2. VOC Content of Field-Applied Interior Primers, Stains, and Transparent Finishes: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to primers, stains, and transparent finishes that are applied in a fabrication or finishing shop:
 - a. Flat Primers: VOC content of not more than 50 g/L.
 - b. Nonflat Primers: VOC content of not more than 150 g/L.
 - c. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
 - d. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
 - e. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
 - f. Floor Coatings: VOC not more than 100 g/L.
 - g. Shellacs, Clear: VOC not more than 730 g/L.
 - h. Stains: VOC not more than 250 g/L.
3. Stain Colors: As selected from manufacturer's full range **OR** Match samples **OR** As indicated in a color schedule, **as directed**.

B. Wood Fillers

1. Wood Filler Paste: MPI #91.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

C. Primers And Sealers

1. Exterior Alkyd Wood Primer: MPI #5.
 - a. VOC Content: E Range of E2 **OR** E3, **as directed**.
2. Exterior Latex Wood Primer: MPI #6.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Exterior Oil Wood Primer: MPI #7.
 - a. VOC Content: E Range of E2.
4. Wood Preservative: MPI #37.
 - a. VOC Content: E Range of E1 **OR** E3, **as directed**.
5. Alkyd Sanding Sealer: MPI #102.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
6. Lacquer Sanding Sealer: MPI #84.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
7. Shellac: MPI #88.
 - a. VOC Content: E Range of E2 **OR** E3, **as directed**.

D. Stains

1. Exterior Semitransparent Stain (Solvent Based): MPI #13.
 - a. VOC Content: E Range of E1 **OR** E2, **as directed**.
2. Exterior Solid-Color Stain (Solvent Based): MPI #14.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Exterior, Solid-Color Latex Stain: MPI #16.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
4. Stain for Wood Decks: MPI #33.
 - a. VOC Content: E Range of E1 **OR** E3, **as directed**.
5. Interior Wood Stain (Semitransparent): MPI #90.

- a. VOC Content: E Range of E1 **OR** E2, **as directed**.

E. Varnishes

- 1. Exterior Marine Spar Varnish (Gloss): MPI #28, Gloss Level 7.
 - a. VOC Content: E Range of E1 **OR** E2, **as directed**.
- 2. Exterior Varnish (Gloss): MPI #29, Gloss Level 6.
 - a. VOC Content: E Range of E1.
- 3. Exterior Varnish (Semigloss): MPI #30, Gloss Level 5.
 - a. VOC Content: E Range of E1.
- 4. Interior Varnish (Flat): MPI #73, Gloss Level 1, alkyd type.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
- 5. Interior Varnish (Semigloss): MPI #74, Gloss Level 5, alkyd type.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
- 6. Interior Varnish (Gloss): MPI #75, Gloss Level 6, alkyd type.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

F. Polyurethane Finishes

- 1. Two-Component Aliphatic Polyurethane (Clear): MPI #78.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
- 2. Interior, Oil-Modified, Clear Urethane (Satin): MPI #57, Gloss Level 4.
 - a. VOC Content: E Range of E1 **OR** E2, **as directed**.
- 3. Interior, Oil-Modified, Clear Urethane (Gloss): MPI #56, Gloss Level 6.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
- 4. Moisture-Cured Clear Polyurethane (Flat): MPI #71, Gloss Level 1.
 - a. VOC Content: E Range of E2.
- 5. Moisture-Cured Clear Polyurethane (Gloss): MPI #31.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

G. Waterborne Acrylic Finishes

- 1. Waterborne Clear Acrylic (Satin): MPI #128, Gloss Level 4.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
- 2. Waterborne Clear Acrylic (Semigloss): MPI #129, Gloss Level 5.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
- 3. Waterborne Clear Acrylic (Gloss): MPI #130, Gloss Level 6.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
 - b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.

H. Lacquers

- 1. Lacquer (Clear Flat): MPI #87, Gloss Level 1.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
- 2. Lacquer (Clear Satin): MPI #85, Gloss Level 4.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
- 3. Lacquer (Clear Gloss): MPI #86, Gloss Level 6.
 - a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

I. Oil Finish

- 1. Danish Oil: MPI #92.
 - a. VOC Content: E Range of E3.

1.3 EXECUTION

A. Preparation

1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
 2. Remove plates, machined surfaces, and similar items already in place that are not to be finished. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.
 - a. After completing finishing operations, reinstall items that were removed; use workers skilled in the trades involved. Remove surface-applied protection if any.
 3. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each particular substrate condition and as specified.
 - a. Remove surface dirt, oil, or grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
 - b. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.
 - c. Countersink steel nails, if used, and fill with putty tinted to final color to eliminate rust leach stains.
 4. Apply wood filler paste to open-grain woods, as defined in "MPI Architectural Painting Specification Manual," to produce smooth, glasslike finish.
- B. Application
1. Apply finishes according to manufacturer's written instructions.
 - a. Use applicators and techniques suited for finish and substrate indicated.
 - b. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
 2. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.
- C. Field Quality Control
1. The following procedure may be requested at any time and as often as the Owner deems necessary during the period when finishes are being applied:
 - a. Engage the services of a qualified testing agency to sample finish materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 - b. Testing agency will perform tests for compliance with product requirements.
 - c. the Owner may direct Contractor to stop applying finishes if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying materials from Project site, pay for testing, and refinish surfaces finished with rejected materials. Contractor will be required to remove rejected materials from previously finished surfaces if, on refinishing with complying materials, the two finishes are incompatible.
- D. Cleaning And Protection
1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
 2. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
 3. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by the Owner, and leave in an undamaged condition.
 4. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.
- E. Exterior Wood-Finish-System Schedule
1. Exposed Glue-Laminated Beam and Column Substrates:
 - a. Solid-Color, Solvent-Based Stain System: MPI EXT 6.1C.

- 1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
- 2) Two Stain Coats: Exterior solid-color stain (solvent based).
- b. Varnish Over Semitransparent Stain System: MPI EXT 6.1D.
 - 1) Stain Coat: Exterior semitransparent stain (solvent based).
 - 2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Exterior marine spar varnish (gloss) **OR** varnish (gloss) **OR** varnish (semigloss), **as directed**.
- c. Varnish System: MPI EXT 6.1K.
 - 1) Four (for a Premium Grade system) **OR** Three, **as directed**, Finish Coats: Exterior marine spar varnish (gloss) **OR** varnish (gloss) **OR** varnish (semigloss), **as directed**.
- d. Clear, Two-Component Polyurethane Over Stain System: MPI EXT 6.1E.
 - 1) Stain Coat: Exterior semitransparent stain (solvent based).
 - 2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Two-component aliphatic polyurethane (clear).
- e. Clear, Two-Component Polyurethane System: MPI EXT 6.1H.
 - 1) Three Finish Coats: Two-component aliphatic polyurethane (clear).
2. Exposed Rough Carpentry Substrates:
 - a. Solid-Color Latex Stain System: MPI EXT 6.2B.
 - 1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
 - 2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior, solid-color latex stain.
 - b. Solid-Color, Solvent-Based Stain System: MPI EXT 6.2D.
 - 1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
 - c. Two Stain Coats (for a Premium Grade system) One Stain Coat, **as directed**: Exterior solid-color stain (solvent based).
 - d. Semitransparent Stain System: MPI EXT 6.2L.
 - 1) Two Stain Coats: Exterior semitransparent stain (solvent based).
 - e. Varnish Over Semitransparent Stain System: MPI EXT 6.2E.
 - 1) Stain Coat: Exterior semitransparent stain (solvent based).
 - 2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Exterior marine spar varnish (gloss) **OR** varnish (gloss) **OR** varnish (semigloss), **as directed**.
 - f. Varnish System: MPI EXT 6.2K.
 - 1) Four (for a Premium Grade system) **OR** Three, **as directed**, Finish Coats: Exterior varnish (marine spar, high gloss) **OR** (gloss) **OR** (semigloss), **as directed**.
 - g. Clear, Two-Component Polyurethane System: MPI EXT 6.2H.
 - 1) Three Finish Coats: Two-component aliphatic polyurethane (clear).
3. Finish Carpentry Substrates:
 - a. Solid-Color Latex Stain System: MPI EXT 6.3K.
 - 1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
 - 2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior, solid-color latex stain.
 - b. Solid-Color, Solvent-Based Stain System: MPI EXT 6.3C.
 - 1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
 - 2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior solid-color stain (solvent based).
 - c. Semitransparent Stain System: MPI EXT 6.3D.
 - 1) Two Stain Coats: Exterior semitransparent stain (solvent based).
 - d. Varnish Over Semitransparent Stain System: MPI EXT 6.3E.
 - 1) Stain Coat: Exterior semitransparent stain (solvent based).
 - 2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Exterior varnish (marine spar, high gloss) **OR** (gloss) **OR** (semigloss), **as directed**.
 - e. Varnish System: MPI EXT 6.3F.
 - 1) Four (for a Premium Grade system) **OR** Three, **as directed**, Finish Coats: Exterior varnish (marine spar, high gloss) **OR** (gloss) **OR** (semigloss), **as directed**.
 - f. Clear, Two-Component Polyurethane System: MPI EXT 6.3G.
 - 1) Three Finish Coats: Two-component aliphatic polyurethane (clear).

F. Exposed Wood Panel-Product Substrates:

- a. Solid-Color Latex Stain System: MPI EXT 6.4A.
 - 1) Prime Coat: Exterior alkyd **OR** latex **OR** oil, **as directed**, wood primer.
 - 2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior, solid-color latex stain.
 - b. Solid-Color, Solvent-Based Stain System: MPI EXT 6.4C.
 - 1) Prime Coat (for a Premium Grade system): Exterior alkyd **OR** oil, **as directed**, wood primer.
 - 2) Two Stain Coats: Exterior solid-color stain (solvent based).
 - c. Semitransparent Stain System: MPI EXT 6.4D.
 - 1) Two Stain Coats: Exterior semitransparent stain (solvent based).
 - d. Varnish Over Semitransparent Stain System: MPI EXT 6.4J.
 - 1) Stain Coat: Exterior semitransparent stain (solvent based).
 - 2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Exterior varnish (marine spar, high gloss) **OR** (gloss) **OR** (semigloss), **as directed**.
 - e. Varnish System: MPI EXT 6.4H.
 - 1) Four (for a Premium Grade system) **OR** Three, **as directed**, Finish Coats: Exterior varnish (marine spar, high gloss) **OR** (gloss) **OR** (semigloss), **as directed**.
2. Wood Deck and Stair Substrates:
- a. MPI EXT 6.5D.
 - 1) Preservative Coat: Wood preservative.
 - 2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Stain for wood decks.
 - b. MPI EXT 6.5F.
 - 1) Two Stain Coats: Stain for wood decks.
3. Wood Shingle and Shake Substrates (Excluding Roofs):
- a. Solid-Color Latex Stain System: MPI EXT 6.6D.
 - 1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
 - 2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior, solid-color latex stain.
 - b. Solid-Color, Solvent-Based Stain System: MPI EXT 6.6C.
 - 1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
 - 2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior solid-color stain (solvent based).
 - c. Semitransparent Stain System: MPI EXT 6.6F.
 - 1) Two Stain Coats: Exterior semitransparent stain (solvent based).

G. Interior Wood-Finish-System Schedule

1. Exposed Glue-Laminated Beam and Column Substrates:
 - a. Alkyd Varnish Over Stain System: MPI INT 6.1K.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Alkyd Varnish Over Stain and Sealer System: MPI INT 6.1P.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Seal Coat: Alkyd sanding sealer.
 - 3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Alkyd Varnish Over Sealer System: MPI INT 6.1C.
 - 1) Seal Coat: Alkyd sanding sealer.
 - 2) Two Finish Coats: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - d. Polyurethane Varnish Over Stain System: MPI INT 6.1J.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.

- e. Polyurethane Varnish System: MPI INT 6.1D.
 - 1) One Factory-Applied Finish Coat: Matching field-applied finish coats.
 - 2) Two Field-Applied Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.
- f. Moisture-Cured Clear Polyurethane Over Stain System: MPI INT 6.1S.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Moisture-cured clear polyurethane (flat) **OR** (gloss), **as directed**.
- g. Waterborne Clear Acrylic Over Stain System: MPI INT 6.1R.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
- h. Waterborne Clear Acrylic System: MPI INT 6.F.
 - 1) Three Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
- i. Solid-Color Latex Stain System: MPI INT 6.1T.
 - 1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
 - 2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior, solid-color latex stain.
- j. Solid-Color, Solvent-Based Stain System: MPI INT 6.1H.
 - 1) Two Stain Coats: Exterior solid-color stain (solvent based).
- k. Semitransparent Stain System: MPI INT 6.1G.
 - 1) Two Stain Coats: Exterior semitransparent stain (solvent based).
2. Exposed Rough Carpentry Substrates:
 - a. Alkyd Varnish Over Stain and Sealer System: MPI INT 6.2K.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Seal Coat: Alkyd sanding sealer.
 - 3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Alkyd Varnish Over Sealer System: MPI INT 6.2P.
 - 1) Seal Coat: Alkyd sanding sealer.
 - 2) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Polyurethane Varnish Over Stain System: MPI INT 6.2J.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.
 - d. Polyurethane Varnish System: MPI INT 6.2H.
 - 1) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.
 - e. Moisture-Cured Clear Polyurethane Over Stain System: MPI INT 6.2N.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Moisture-cured clear polyurethane (flat) **OR** (gloss), **as directed**.
 - f. Waterborne Clear Acrylic Over Stain System: MPI INT 6.2M.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
3. Finish Carpentry Substrates:
 - a. Alkyd Varnish Over Stain and Sealer System: MPI INT 6.3D.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Seal Coat: Alkyd sanding sealer **OR** Shellac, **as directed**.
 - 3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (semigloss) **OR** (gloss), **as directed**.
 - b. Alkyd Varnish Over Sealer System: MPI INT 6.3J.
 - 1) Seal Coat: Alkyd sanding sealer **OR** Shellac, **as directed**.

- 2) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (semigloss) **OR** (gloss), **as directed**.
- c. Polyurethane Varnish Over Stain System: MPI INT 6.3E.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.
- d. Polyurethane Varnish System: MPI INT 6.3K.
 - 1) One Factory-Applied Finish Coat: Matching field-applied finish coats.
 - 2) Two Field-Applied Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.
- e. Moisture-Cured Clear Polyurethane Over Stain System: MPI INT 6.3Y.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Moisture-cured clear polyurethane (flat) **OR** (gloss), **as directed**.
- f. Moisture-Cured Clear Polyurethane System: MPI INT 6.3X.
 - 1) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Moisture-cured clear polyurethane (flat) **OR** (gloss), **as directed**.
- g. Clear, Two-Component Polyurethane System: MPI INT 6.3Z.
 - 1) Three (for a Premium Grade system) Two, **as directed**, Finish Coats: Two-component aliphatic polyurethane (clear).
- h. Waterborne Clear Acrylic Over Stain System: MPI INT 6.3W.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
- i. Waterborne Clear Acrylic System: MPI INT 6.3Q.
 - 1) Three Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
- j. Lacquer Over Stain and Sealer System: MPI INT 6.3F.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Seal Coat: Lacquer sanding sealer.
 - 3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Lacquer (clear flat **OR** satin **OR** gloss, **as directed**).
- k. Lacquer Over Sealer System: MPI INT 6.3H.
 - 1) Seal Coat: Lacquer sanding sealer.
 - 2) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Lacquer (clear flat **OR** satin **OR** gloss, **as directed**).
- l. Semitransparent Stain System: MPI INT 6.3C.
 - 1) Two Stain Coats: Exterior semitransparent stain (solvent based).
- m. Danish Oil System: MPI INT 6.3M.
 - 1) Two Finish Coats: Danish oil.
4. Exposed Wood Panel-Product Substrates:
 - a. Alkyd Varnish Over Sealer and Stain System: MPI INT 6.4D.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Seal Coat: Alkyd sanding sealer **OR** Shellac, **as directed**.
 - 3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - b. Alkyd Varnish Over Sealer System: MPI INT 6.4G.
 - 1) Seal Coat: Alkyd sanding sealer **OR** Shellac, **as directed**.
 - 2) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
 - c. Polyurethane Varnish Over Stain System: MPI INT 6.4E.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.
 - d. Polyurethane Varnish System: MPI INT 6.4J.

- 1) One Factory-Applied Finish Coat: Matching field-applied finish coats.
- 2) Two Field-Applied Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.
- e. Moisture-Cured Clear Polyurethane Over Stain System: MPI INT 6.4V.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Three (for a Premium Grade system) Two, **as directed**, Finish Coats: Moisture-cured clear polyurethane (flat) **OR** (gloss), **as directed**.
- f. Waterborne Clear Acrylic Over Stain System: MPI INT 6.4U.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
- g. Lacquer Over Stain and Sealer System: MPI INT 6.4F.
 - 1) Stain Coat: Interior wood stain (semitransparent).
 - 2) Seal Coat: Lacquer sanding sealer.
 - 3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Lacquer (clear flat **OR** satin **OR** gloss, **as directed**).
- h. Lacquer Over Sealer System: MPI INT 6.4Y.
 - 1) Seal Coat: Lacquer sanding sealer.
 - 2) Three (for a Premium Grade system) Two, **as directed**, Finish Coats: Lacquer (clear flat **OR** satin **OR** gloss, **as directed**).
- i. Semitransparent Stain System: MPI INT 6.4C.
 - 1) Two Stain Coats: Exterior semitransparent stain (solvent based).
- j. Danish Oil System: MPI INT 6.4K.
 - 1) Two Finish Coats: Danish oil.

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Task	Specification	Specification Description
09 91 33 00	09 91 13 00a	High-Temperature-Resistant Coatings

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SECTION 10 11 16 13 - VISUAL DISPLAY SURFACES

1.1 GENERAL

A. Description Of Work:

1. This specification covers the furnishing and installation of materials for visual display surfaces. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
 - a. Chalkboards.
 - b. Markerboards.
 - c. Tackboards.
 - d. Visual display rails.
 - e. Visual display wall panels.
 - f. Support systems for visual display boards.
 - g. Sliding visual display units.
 - h. Visual display conference units.
 - i. Visual display wall coverings.
 - j. Electronic markerboards.

C. Definitions

1. Tackboard: Framed or unframed, tackable, visual display board assembly.
2. Visual Display Board Assembly: Visual display surface that is factory fabricated into composite panel form, either with or without a perimeter frame; includes chalkboards, markerboards, and tackboards.
3. Visual Display Surface: Surfaces that are used to convey information visually, including surfaces of chalkboards, markerboards, tackboards, and surfacing materials that are not fabricated into composite panel form but are applied directly to walls.

D. Submittals

1. Product Data: For each type of product indicated.
 - a. Include rated capacities, operating characteristics, electrical characteristics and individual panel weights for sliding visual display units.
 - b. Include computer system requirements for electronic markerboards.
2. LEED Submittals:
 - a. Product Data for Credit EQ 4.4: For composite wood products, documentation indicating that the product contains no urea formaldehyde.
 - b. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content and chemical components.
3. Shop Drawings: For visual display surfaces. Include plans, elevations, sections, details, and attachments to other work.
 - a. Show locations of panel joints.
 - b. Show locations of special-purpose graphics for visual display surfaces.
 - c. Include sections of typical trim members.
 - d. Wiring Diagrams: For power, signal, and control wiring.
4. Samples: For each exposed product and for each color and texture specified.
5. Qualification Data: For qualified Installer.
6. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of fabrics.
7. Operation and Maintenance Data: For visual display surfaces and power-operated units to include in maintenance manuals.

8. Warranties: Sample of special warranties.

E. Quality Assurance

1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of motor-operated, sliding visual display units required for this Project.
2. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling

1. Deliver factory-built visual display surfaces, including factory-applied trim where indicated, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to the Owner. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.
2. Store visual display surfaces vertically with packing materials between each unit.

G. Project Conditions

1. Environmental Limitations: Do not deliver or install visual display surfaces until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Field Measurements: Verify actual dimensions of construction contiguous with visual display surfaces by field measurements before fabrication.
 - a. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

H. Warranty

1. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer's standard form in which manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
 - a. Failures include, but are not limited to, the following:
 - 1) Surfaces lose original writing and erasing qualities.
 - 2) Surfaces exhibit crazing, cracking, or flaking.
 - b. Warranty Period: 50 years from date of Final Completion **OR** Life of the building, **as directed**.
2. Special Warranty for Electronic Markerboards: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic markerboards that fail in materials or workmanship within two years from date of Final Completion.

1.2 PRODUCTS

A. Materials, General

1. Porcelain-Enamel Face Sheet: ASTM A 424, enameling-grade steel, uncoated thickness indicated; with exposed face and edges coated with primer, **1.7-to-2.5-mil- (0.043-to-0.064-mm-)** thick ground coat, and color cover coat; and with concealed face coated with primer and **1.7-to-2.5-mil- (0.043-to-0.064-mm-)** thick ground coat.
 - a. Matte-Finish Cover Coat: Low reflective; chalk wipes clean with dry cloth or standard eraser. Minimum **2.0-to-2.5-mil- (0.051-to-0.064-mm-)** thick cover coat. Cover and ground

- coats shall be fused to steel at manufacturer's standard firing temperatures but not less than **1250 deg F (677 deg C)**.
- b. Gloss-Finish Cover Coat: Gloss as indicated; dry-erase markers wipe clean with dry cloth or standard eraser. Minimum **3.0-to-4.0-mil- (0.076-to-0.102-mm-)** thick cover coat. Cover and ground coats shall be fused to steel at manufacturer's standard firing temperatures but not less than **1475 deg F (802 deg C)**.
 2. Porcelain-Enamel Face Sheet: Porcelain-enamel-clad, ASTM A 463/A 463M, Type 1, stretcher-leveled aluminized steel, with **0.024-inch (0.60-mm)** uncoated thickness; with porcelain-enamel coating fused to steel at approximately **1000 deg F (538 deg C)**.
 - a. Matte Finish: Low reflective; chalk wipes clean with dry cloth or standard eraser.
 - b. Gloss Finish: Low gloss; dry-erase markers wipe clean with dry cloth or standard eraser. Suitable for use as projection screen.
 3. Porcelain-Enamel Face Sheet: Manufacturer's standard steel sheet with porcelain-enamel coating fused to steel; uncoated thickness indicated.
 - a. Matte Finish: Low reflective; chalk wipes clean with dry cloth or standard eraser.
 - b. Gloss Finish: Gloss as indicated; dry-erase markers wipe clean with dry cloth or standard eraser.
 4. Melamine: Thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.
 5. High-Pressure Plastic Laminate: NEMA LD 3.
 6. Natural Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish with surface-burning characteristics indicated.
 7. Plastic-Impregnated Cork Sheet: Seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto fabric backing; with washable vinyl finish and integral color throughout with surface-burning characteristics indicated.
 8. Vinyl Fabric: Mildew resistant, washable, complying with FS CCC-W-408D, Type II, burlap weave; weighing not less than **13 oz./sq. yd. (440 g/sq. m)**; with surface-burning characteristics indicated.
 9. Polyester Fabric: Nondirectional weave, 100 percent polyester; weighing not less than **15 oz./sq. yd. (508 g/sq. m)**; with surface-burning characteristics indicated.
 10. Hardboard: ANSI A135.4, tempered.
 11. Particleboard: ANSI A208.1, Grade M-1, made with binder containing no urea formaldehyde.
 12. Fiberboard: ASTM C 208.
 13. Extruded Aluminum: **ASTM B 221 (ASTM B 221M)**, Alloy 6063.

B. Chalkboard Assemblies

1. Porcelain-Enamel Chalkboards: Balanced, high-pressure, factory-laminated chalkboard assembly of three-ply construction consisting of backing sheet, core material, and **0.021-inch- (0.53-mm-)** thick, **OR 0.013-inch- (0.33-mm-)** thick, **as directed**, porcelain-enamel face sheet with matte finish.
 - a. Hardboard Core: **1/4 inch (6 mm)** thick; with **0.005-inch- (0.127-mm-)** thick, aluminum foil **OR 0.015-inch- (0.38-mm-)** thick, aluminum sheet **OR 0.0129-inch- (0.35-mm-)** thick, galvanized-steel sheet, **as directed**, backing.
 - b. Particleboard Core: **3/8 inch (9.5 mm)** thick; with **0.005-inch- (0.127-mm-)** thick, aluminum foil **OR 0.015-inch- (0.38-mm-)** thick, aluminum sheet **OR 0.0129-inch- (0.35-mm-)** thick, galvanized-steel sheet, **as directed**, backing.
 - c. Fiberboard Core: **3/8 inch (9.5 mm) OR 1/2 inch (13 mm)**, **as directed**, thick; with **0.001-inch- (0.025-mm-)** thick, aluminum foil **OR 0.015-inch- (0.38-mm-)** thick, aluminum sheet **OR 0.0129-inch- (0.35-mm-)** thick, galvanized-steel sheet, **as directed**, backing.
 - d. Manufacturer's Standard Core: Minimum **1/4 inch (6 mm)** thick, with manufacturer's standard moisture-barrier backing.
 - e. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.
2. High-Pressure-Laminate Chalkboards: Balanced, high-pressure, factory-laminated chalkboard assembly of two-ply construction consisting of fiberboard core material and high-pressure-laminate writing surface.

3. Melamine Chalkboards: Fabricated from **1/4-inch- (6-mm-)** thick, sealed and primed hardboard panels permanently bonded with melamine writing surface.
4. Painted-Finish Chalkboards: Fabricated from two plies of **1/4-inch- (6-mm-)** thick, treated, tempered hardboard panels permanently surfaced with manufacturer's standard, heat-cured organic coating formulated for chalk-receptive matte finish.
5. Natural-Slate Chalkboards: Select grade, resurfaced, natural slate; free from ribbons and other natural marks that impair their functional use and durability as a writing surface.
 - a. Writing surface shall be free of tooling marks, pits, chipping, scratches, and surface spalls in excess of those that can be easily corrected; and shall be free of surface-applied stain, dye, or other artificial coloring.
 - b. Thickness: Not less than **1/4 inch (6 mm)** or more than **3/8 inch (9.5 mm)** thick with maximum deviation of **1/16 inch (1.6 mm)** when an average thickness of at least **1/4 inch (6 mm)** is maintained.

C. Markerboard Assemblies

1. Porcelain-Enamel Markerboards: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction consisting of backing sheet, core material, and **0.021-inch- (0.53-mm-)** thick, **OR 0.013-inch- (0.33-mm-)** thick, **as directed**, porcelain-enamel face sheet with high-gloss **OR** low-gloss, **as directed**, finish.
 - a. Hardboard Core: **1/4 inch (6 mm)** thick; with **0.005-inch- (0.127-mm-)** thick, aluminum foil **OR 0.015-inch- (0.38-mm-)** thick, aluminum sheet **OR 0.013-inch- (0.35-mm-)** thick, galvanized-steel sheet, **as directed**, backing.
 - b. Particleboard Core: **3/8 inch (9.5 mm)** **OR 1/2 inch (13 mm)**, **as directed**, thick; with **0.005-inch- (0.127-mm-)** thick, aluminum foil **OR 0.015-inch- (0.38-mm-)** thick, aluminum sheet **OR 0.013-inch- (0.35-mm-)** thick, galvanized-steel sheet, **as directed**, backing.
 - c. Fiberboard Core: **3/8 inch (9.5 mm)** **OR 1/2 inch (13 mm)**, **as directed**, thick; with **0.001-inch- (0.025-mm-)** thick, aluminum foil **OR 0.015-inch- (0.38-mm-)** thick, aluminum sheet **OR 0.013-inch- (0.35-mm-)** thick, galvanized-steel sheet, **as directed**, backing.
 - d. Manufacturer's Standard Core: Minimum **1/4 inch (6 mm)** thick, with manufacturer's standard moisture-barrier backing.
 - e. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.
2. Melamine Markerboards: Fabricated from **1/4-inch- (6-mm-)** thick, sealed and primed hardboard panels permanently bonded with melamine or another high-pressure-laminate writing surface.
3. High-Pressure-Laminate Markerboard Assembly: Balanced, high-pressure, factory-laminated chalkboard assembly of three-ply construction consisting of backing sheet, fiberboard core material, and high-pressure-laminate writing surface.

D. Tackboard Assemblies

1. Natural-Cork Tackboard:
 - a. **1/16-inch- (1.6-mm-)** thick, natural cork sheet factory laminated to **3/8-inch- (9.5-mm-)** **OR 7/16-inch- (11-mm-)**, **as directed**, thick fiberboard backing.
 - b. **1/8-inch- (3-mm-)** thick, natural cork sheet factory laminated to **3/8-inch- (9.5-mm-)** thick fiberboard backing.
 - c. **1/4-inch- (6-mm-)** thick, natural cork sheet factory laminated to **1/4-inch- (6-mm-)** thick hardboard **OR** particleboard, **as directed**, backing.
2. Plastic-Impregnated-Cork Tackboard:
 - a. **1/8-inch- (3-mm-)** thick, plastic-impregnated cork sheet factory laminated to **3/8-inch- (9.5-mm-)** thick fiberboard backing.
 - b. **1/4-inch- (6-mm-)** thick, plastic-impregnated cork sheet factory laminated to **1/4-inch- (6-mm-)** thick hardboard **OR** particleboard, **as directed**, backing.
3. Vinyl-Fabric-Faced Tackboard:
 - a. Vinyl fabric factory laminated to **3/8-inch- (9.5-mm-)** **OR 7/16-inch- (11-mm-)** **OR 1/2-inch- (13-mm-)**, **as directed**, thick fiberboard backing.
 - b. **1/16-inch- (1.6-mm-)** thick, vinyl-fabric-faced cork sheet factory laminated to **3/8-inch- (9.5-mm-)** thick fiberboard backing.

- c. **1/8-inch- (3-mm-)** thick, vinyl-fabric-faced cork sheet factory laminated to **3/8-inch- (9.5-mm-)** thick fiberboard backing.
 - d. **1/4-inch- (6-mm-)** thick, vinyl-fabric-faced cork sheet factory laminated to **1/4-inch- (6-mm-)** thick hardboard **OR** particleboard, **as directed**, backing.
 4. Polyester-Fabric-Faced Tackboard:
 - a. Polyester fabric factory laminated to **3/8-inch- (9.5-mm-)** **OR** **1/2-inch- (13-mm-)**, **as directed**, thick fiberboard backing.
 - b. **1/16-inch- (1.6-mm-)** thick, polyester-fabric-faced cork sheet factory laminated to **3/8-inch- (9.5-mm-)** thick fiberboard backing.
 - c. **1/8-inch- (3-mm-)** thick, polyester-fabric-faced cork sheet factory laminated to **3/8-inch- (9.5-mm-)** thick fiberboard backing.
 - d. **1/4-inch- (6-mm-)** thick, polyester-fabric-faced cork sheet factory laminated to **1/4-inch- (6-mm-)** thick hardboard **OR** particleboard, **as directed**, backing.
- E. Visual Display Rails
 1. General: Manufacturer's standard, aluminum-framed, tackable cork **OR** fabric, **as directed**, visual display surface fabricated into narrow rail shape and designed for displaying material.
- F. Visual Display Wall Panels
 1. Marker Wall Sheets: Fabricated from **0.021-inch (0.53-mm)** uncoated thickness, porcelain-enamel face sheets; for direct application to wall surface.
 2. Marker Wall Panels: Fabricated from markerboard assembly indicated.
 3. Tack Wall Panels: With tackable surface.
 - a. Fabricated from tackboard assembly indicated.
 - b. Natural Cork: **1/8-inch- (3-mm-)** **OR** **1/4-inch- (6-mm-)**, **as directed**, thick, natural cork sheet for direct application to wall surface.
 - c. Plastic-Impregnated Cork: **1/8-inch- (3-mm-)** **OR** **1/4-inch- (6-mm-)**, **as directed**, thick, plastic-impregnated cork sheet for direct application to wall surface.
 - d. Vinyl Fabric-Faced Cork: **1/4-inch- (6-mm-)** thick, vinyl-fabric-faced cork sheet for direct application to wall surface.
 - e. Polyester-Fabric-Faced Cork: **1/4-inch- (6-mm-)** thick, polyester-fabric-faced cork sheet for direct application to wall surface.
 4. Joint Accessories: Manufacturer's standard, exposed trim **OR** concealed aluminum or steel spline, **as directed**, at butt joints.
 5. Adhesive: Mildew-resistant, nonstaining adhesive, for use with specific tack wall panels and substrate application, as recommended in writing by visual display surface manufacturer, and with a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 6. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in Division 09 Section "Interior Painting" and recommended in writing by visual display surface manufacturer for intended substrate.
- G. Rail Support System For Visual Display Boards
 1. Support Rails: Horizontal, wall-mounted, extruded-aluminum rails designed to receive hanger clip and to support visual display boards; capable of gripping and suspending paper directly from rail.
 - a. Finish: Clear anodic **OR** Color anodic **OR** Baked enamel **OR** Powder coat, **as directed**.
 - b. Color and Gloss: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
 2. Hanger Clips: Extruded aluminum with finish to match rails; designed to support independent visual display boards by engaging support rail and top trim of board.
 3. Visual Display Panels: Fabricated from not less than **3/8-inch- (9.5-mm-)** thick, kraft-paper honeycomb core; designed to be rigid and to resist warpage, and with aluminum trim designed to engage hanger clips.
- H. Modular Support System For Visual Display Boards

1. Standards: **72-inch- (1829-mm-)** long, extruded-aluminum slotted standards designed for supporting visual display boards on panel clips. Standards shall be punched at not less than **4 inches (100 mm)** o.c.
 - a. Finish: Clear anodic **OR** Color anodic **OR** Baked enamel **OR** Powder coat, **as directed**.
 - b. Color and Gloss: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
2. Panel Clips: Extruded aluminum or steel with finish to match standards.

I. Sliding Visual Display Units

1. Horizontal-Sliding Visual Display Units: Factory-fabricated units consisting of extruded-aluminum tubular frame, fixed-rear visual display panel, aluminum-framed horizontal-sliding panels, and extruded-aluminum fascia that conceals overhead sliding track; designed for recessed mounting. Provide panels that operate smoothly without vibration or chatter.
 - a. Two-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide two sliding panels, each equal to not less than one-half of overall length of unit.
 - b. Three-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide three sliding panels, each equal to not less than one-third **OR** one-half, **as directed**, of overall length of unit.
 - c. Four-Track Units: Fabricate unit with fixed rear panel centered in and covering not less than one-half of rear surface, and fixed front panel on each side of unit equal to not less than one-quarter of overall length of unit. Provide four sliding panels, each equal to not less than one-quarter of overall length of unit.
 - 1) Swinging Doors: Fabricated from same construction as sliding panels and supported on full-height continuous hinges. Provide visual display surface on both sides of each door.
 - d. Sliding Panels: Fabricated from not less than **3/8-inch- (9.5-mm-)** thick, kraft-paper honeycomb core; designed to be rigid and to resist warpage.
 - 1) Fabricate sliding panels with **0.021-inch (0.53-mm)** uncoated thickness, porcelain-enamel face sheets.
 - e. Hardware: Manufacturer's standard, extruded-aluminum overhead track and channel-shaped bottom guides; with two nylon ball-bearing carriers and two nylon rollers for each sliding panel.
2. Vertical-Sliding Visual Display Units: Factory-fabricated units consisting of extruded-aluminum tubular frame, fixed-rear visual display panel, and aluminum-framed vertical-sliding panels; designed for recessed mounting. Provide panels that operate smoothly without vibration or chatter.
 - a. Type: Tubular frame on four sides **OR** top and two sides, with sides extending to floor; with kick panel to conceal sliding panels, **as directed**. Unit shall be designed to support panels independent of wall.
 - b. Two-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide two sliding panels, each equal to not less than one-half of overall height of unit.
 - c. Three-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide three sliding panels, each equal to not less than one-half of overall height of unit.
 - d. Four-Track Units: Fabricate unit with fixed rear panel centered in and covering not less than one-half of rear surface. Provide four sliding panels, each equal to not less than one-half of overall height of unit.
 - e. Sliding Panels: Fabricated from not less than **3/8-inch- (9.5-mm-)** thick, kraft-paper honeycomb core; designed to be rigid and to resist warpage.
 - 1) Fabricate sliding panels with **0.021-inch (0.53-mm)** uncoated thickness, porcelain-enamel face sheets.
 - f. Hardware: Manufacturer's standard, neoprene ball-bearing end rollers, four on each side of each sliding panel. Counterbalance each sliding panel with lead counterweights supported by steel aircraft cable over ball-bearing sheaves; with removable cover plate for

- access to counterweights. Provide rubber bumpers at top and bottom for each sliding panel.
- g. Motorized Operation: Provide not less than one motor with gearhead reducers for each sliding panel, mounted above visual display unit and connected to sliding panels with steel aircraft cable. Provide removable cover plate for access to motor. Equip motors with limit switches to automatically stop motor at each end of travel.
 - 1) Electric Motors: UL approved or recognized, totally enclosed, complying with NEMA MG 1, with thermal-overload protection; 1/15 hp, single phase, 110 **OR** 220, **as directed**, V, 60 Hz.
 - 2) Control Station: Three-position, maintained-contact **OR** momentary-contact, **as directed**, switch-operated control station with open, close, and off functions; with NEMA ICS 6, Type 1 enclosure. Provide one control station for each sliding panel unit, unless directed otherwise.
 - 3) Key Switch: Provide supplementary key switch for each control station. Furnish two keys for each control station, keyed alike.
- J. Visual Display Conference Units
1. Visual Display Conference Units: Factory-fabricated units consisting of hinged-door wood cabinet with perimeter face frame, sides, and back; not less than **3-inch (75-mm)** interior depth and designed for surface wall mounting. Fabricate inside of cabinet and cabinet doors with fixed visual display surfaces.
 - a. Wood Cabinets: Fabricated from solid wood with integral, solid-wood markertray. Fabricate hinged door panels with solid wood frame and wood-veneer exterior surface.
 - b. Plastic-Laminate Cabinets: Cabinet and hinged door panels fabricated from manufacturer's standard, high-pressure, plastic-laminate-finished panels; with integral markertray.
 - c. Hardware: Manufacturer's standard, full-height continuous hinges, wire door pulls, and door bumpers.
 - d. Projection Screens: Manufacturer's standard, pull-down, matte, white projection screen, not less than **8 inches (200 mm)** smaller in each direction than overall cabinet size, and mounted above rear visual display surface.
 - e. Fluorescent Light: Manufacturer's standard, not less than **24 inches (610 mm)** long, and mounted above rear visual display surface.
- K. Visual Display Wall Coverings
1. Visual Display Wall Covering: Intended for use with dry-erase markers and as a projection surface, **as directed**, and consisting of low-gloss **OR** moderate-gloss **OR** high-gloss, **as directed**, plastic film bonded to fabric backing; not less than **0.012-mil (0.0003-mm)** **OR** **0.020-mil (0.0005-mm)**, **as directed**, total thickness.
 2. Surface Graphics: **2-inch- (50-mm-)** square grid.
 - a. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
 3. Magnetic Visual Display Wall Covering: Intended for use with dry-erase markers and magnetic aids and consisting of moderate-gloss plastic film bonded to ferrous-powdered fabric backing; not less than **0.025-mil (0.0006-mm)** total thickness.
 - a. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
 4. Adhesive: Mildew-resistant, nonstaining, strippable, **as directed**, adhesive, for use with specific wall covering and substrate application, as recommended in writing by wall covering manufacturer, and with a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 5. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in Division 09 Section "Interior Painting" and recommended in writing by wall covering manufacturer for intended substrate.
- L. Electronic Markerboards

1. General: Provide manufacturer's standard electronic markerboard that consists of touch-sensitive writing surface connected to microcomputer via RS-232 serial cable and that electronically records writing with standard dry-erase markers. Equip unit with cables, software, pens, erasers, mounting hardware, and accessories required for a complete installation.
2. Software: Capable of real-time recording, saving, and printing of everything that is written and drawn on electronic markerboard; with Windows **OR** Macintosh, **as directed**, operating system.
 - a. File Export Formats: BMP, WMF, HTML, and vector-based formats.
 - b. Compatibility: Compatible with Microsoft NetMeeting or other T.120-compliant software.
 - c. Features: Capable of the following:
 - 1) Saving directly from screen.
 - 2) Erasing portions of screen.
 - 3) Printing directly from screen.
 - 4) Saving individual screens as separate pages.
 - 5) Showing onscreen toolbar **OR** keyboard, **as directed**.
 - 6) Recognizing not less than four pen colors.
 - 7) Recognizing finger touch control for presentations.
 - 8) Connecting multiple electronic markerboards to a single computer.
 - 9) Showing online help and tutorial.
3. Overall Size: Approximately **48 inches high by 60 inches wide (1219 mm high by 1524 mm wide)**.
4. Mounting: Wall mounted **OR** Supported by rail support system, **as directed**.

M. Chalkboard, Markerboard, And Tackboard Accessories

1. Aluminum Frames and Trim: Fabricated from not less than **0.062-inch- (1.57-mm-)** thick, extruded aluminum; standard size and shape **OR** slim size and standard shape **OR** of size and shape indicated on Drawings, **as directed**.
 - a. Field-Applied Trim: Manufacturer's standard, snap-on trim with no visible screws or exposed joints **OR** slip-on trim **OR** screw-on trim with Phillips flat-head screws, **as directed**.
 - b. Factory-Applied Trim: Manufacturer's standard.
2. Factory-Applied Wood Trim: Red oak **OR** Walnut **OR** Manufacturer's standard species, **as directed**, not less than **1/2 inch (13 mm)** thick; standard size and shape **OR** of size and shape indicated on Drawings, **as directed**.
3. Field-Applied Wood Trim: Comply with requirements specified in Division 06 Section(s) "Finish Carpentry" **OR** "Interior Architectural Woodwork" **as directed**.
4. Chalktray: Manufacturer's standard, continuous.
 - a. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.
 - b. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.
5. Map Rail: Provide the following accessories:
 - a. Display Rail: Continuous and integral with map rail; fabricated from cork approximately **1 to 2 inches (25 to 50 mm)** wide.
 - b. End Stops: Located at each end of map rail.
 - c. Map Hooks: Two map hooks for every **48 inches (1219 mm)** **OR** 1200 mm, **as directed**, of map rail or fraction thereof.
 - d. Map Hooks and Clips: Two map hooks with flexible metal clips for every **48 inches (1219 mm)** **OR** 1200 mm, **as directed**, of map rail or fraction thereof.
 - e. Flag Holder: One for each room.
 - f. Paper Holder: Extruded aluminum; designed to hold paper by clamping action.
6. Special-Purpose Graphics: Fuse or paint the following graphics into surface of porcelain-enamel visual display unit:
 - a. Semivisible writing guidelines.
 - b. Penmanship lines.
 - c. Music staff lines.
 - d. Grid, **1 inch (25 mm)** square.
 - e. Graph coordinates, rectangular.

- f. Horizontal lines, 2 inches (50 mm) o.c.
- g. Polar coordinates.
- h. USA map.
- i. World map.
- j. Soccer field.
- k. Football field.
- l. Basketball court.

N. Fabrication

1. Porcelain-Enamel Visual Display Assemblies: Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive.
2. Natural-Slate Chalkboards: Surface slate panels to a natural plane. Grind and hone to smooth, uniform finish equivalent to that obtained by minimum 180 grit and maximum 220 grit.
 - a. Cut joints straight and true. Space joints symmetrically. Fit and match panels before shipment to provide continuous, uniform writing surface.
 - b. Length: Furnish panels approximately equal in length with permissible variation not more than 3 inches (75 mm) in either direction of equal spacing. Allow 1/4-inch (6-mm) clearance at trim in length and width for fitting. Provide lengths of panels in each space as follows:
 - 1) Up to 5 feet (1.5 m); one panel.
 - 2) More than 5 feet (1.5 m) but less than 9 feet (2.7 m); two panels.
 - 3) More than 9 feet (2.7 m) but less than 13.5 feet (4.1 m); three panels.
 - 4) More than 13.5 feet (4.1 m) but less than 18 feet (5.5 m); four panels.
 - 5) More than 18 feet (5.5 m) but less than 22.5 feet (6.9 m); five panels.
 - 6) More than 22.5 feet (6.9 m) but less than 27 feet (8.2 m); six panels.
3. Visual Display Boards: Factory **OR** Field, **as directed**, assemble visual display boards unless otherwise indicated.
 - a. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display boards at manufacturer's factory before shipment.
4. Factory-Assembled Visual Display Units: Coordinate factory-assembled units with trim and accessories indicated. Join parts with a neat, precision fit.
 - a. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to the Owner **OR** as indicated on approved Shop Drawings, **as directed**.
 - b. Provide manufacturer's standard vertical-joint spline **OR** H-trim, **as directed**, system between abutting sections of chalkboards **OR** markerboards, **as directed**.
 - c. Provide manufacturer's standard mullion trim at joints between chalkboards **OR** markerboards **OR** tackboards, **as directed**, of combination units.
 - d. Where size of visual display boards or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by the Owner from manufacturer's standard structural support accessories to suit conditions indicated.
5. Modular Visual Display Boards: Fabricated with integral panel clips attached to core material.
6. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to a neat, hairline closure.
 - a. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.

O. General Finish Requirements

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

P. Aluminum Finishes

1. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1.3 EXECUTION

A. Examination

1. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
2. Examine roughing-in for electrical power systems to verify actual locations of connections before installation of motor-operated, sliding visual display units.
3. Examine walls and partitions for proper preparation and backing for visual display surfaces.
4. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.
5. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation

1. Comply with manufacturer's written instructions for surface preparation.
2. Clean substrates of substances that could impair the performance of and affect the smooth, finished surfaces of visual display boards, including dirt, mold, and mildew.
3. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display surfaces and wall surfaces.
 - a. Prime wall surfaces indicated to receive direct-applied, visual display tack wall panels **OR** visual display wall coverings, **as directed**, and as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
 - b. Prepare surfaces to receive visual display wall coverings and test for moisture according to requirements specified in Division 09 Section "Wall Coverings".
OR
 Prepare substrates indicated to receive visual display wall covering as required by manufacturer's written instructions to achieve a smooth, dry, clean, structurally sound surface that is uniform in color.
 - 1) Moisture Content: Maximum of 4 percent when tested with an electronic moisture meter.
 - 2) Plaster: Allow new plaster to cure. Neutralize areas of high alkalinity. Prime with primer as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
 - 3) Metals: If not factory primed, clean and apply metal as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
 - 4) Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
 - 5) Painted Surfaces: Treat areas susceptible to pigment bleeding.
4. Prepare recesses for sliding visual display units as required by type and size of unit.

C. Installation, General

1. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
 - a. Mounting Height for Grades K through 3: **24 inches (610 mm)** above finished floor to top of chalktray.
 - b. Mounting Height for Grades 4 through 6: **28 inches (711 mm)** above finished floor to top of chalktray.
 - c. Mounting Height for Grades 7 and Higher: **36 inches (914 mm)** above finished floor to top of chalktray.

OR

 - a. Mounting heights of **24 inches (610 mm)** above finished floor to top of chalktray for kindergarten.
 - b. Mounting heights of **26 inches (660 mm)** above finished floor to top of chalktray for Grades 1 through 3.
 - c. Mounting heights of **30 inches (762 mm)** above finished floor to top of chalktray for Grades 4 through 6.
 - d. Mounting heights of **34 inches (864 mm)** above finished floor to top of chalktray for Grades 7 through 9.
 - e. Mounting heights of **37 inches (940 mm)** above finished floor to top of chalktray for Grades 10 and higher,
as directed
- D. Installation Of Field-Fabricated Visual Display Boards And Assemblies
 1. Field-Assembled Visual Display Units: Coordinate field-assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit.
 - a. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to the Owner **OR** as indicated on approved Shop Drawings, **as directed**.
 - b. Provide manufacturer's standard vertical-joint spline **OR** H-trim, **as directed**, system between abutting sections of chalkboards **OR** markerboards, **as directed**.
 - c. Provide manufacturer's standard mullion trim at joints between chalkboards **OR** markerboards **OR** tackboards, **as directed**, of combination units.
 - d. Where size of visual display boards or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by the Owner from manufacturer's standard structural support accessories to suit conditions indicated.
 2. Natural-Slate Chalkboards: Align and level joints between adjoining panels and apply manufacturer's recommended joint-filler compound. Hone and finish joints to continuous even plane.
- E. Installation Of Factory-Fabricated Visual Display Boards And Assemblies
 1. Visual Display Boards:
 - a. Attach visual display boards to wall surfaces with egg-size adhesive gobs at **16 inches (400 mm)** o.c., horizontally and vertically.
OR
Attach concealed clips, hangers, and grounds to wall surfaces and to visual display boards with fasteners at not more than **16 inches (400 mm)** o.c. Secure both top and bottom of boards to walls.
 - b. Field-Applied Aluminum Trim: Attach trim over edges of visual display boards and conceal grounds and clips. Attach trim to boards with fasteners at not more than **24 inches (610 mm)** o.c.
 - 1) Attach chalktrays to boards with fasteners at not more than **12 inches (300 mm)** o.c.
 - c. Field-Applied Wood Trim: Install trim according to requirements in Division 06 Section(s) "Finish Carpentry" **OR** "Interior Architectural Woodwork", **as directed**.

- F. Installation Of Visual Display Rails
1. Display Rails: Install rails in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners at not more than **16 inches (400 mm)** o.c.
 - a. Mounting Height: **48 inches (1219 mm)** **OR** **60 inches (1524 mm)**, **as directed**, above finished floor to top of rail.
- G. Installation Of Visual Display Wall Panels
1. Marker Wall Sheets: Attach wall sheets to wall surface with thin layer of adhesive over entire wall surface. Butt join adjacent panels and cover joint with matching joint strip installed with double-stick tape, **as directed**.
 2. Marker Wall Panels: Attach panels to wall surface with egg-size adhesive gobs at **16 inches (400 mm)** o.c., horizontally and vertically.
 - a. Join adjacent wall panels with concealed steel splines for smooth alignment.
OR
Join adjacent wall panels with exposed, H-shaped aluminum trim painted to match wall panel.
 3. Tack Wall Panels: Attach panels to wall surface with egg-size adhesive gobs at **16 inches (400 mm)** o.c. horizontally and vertically.
 - a. Install wrapped-edge wall panels with butt joints between adjacent wall panels.
 - b. Join adjacent wall panels with exposed, H-shaped aluminum trim covered with same fabric as wall panels.
- H. Installation Of Rail **OR** Modular, **as directed**, Support System
1. Rail Support System: Install horizontal support rail in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners at **12 inches (300 mm)** o.c.
 - a. Mounting Height: **72 inches (1829 mm)** above finished floor to top of rail.
 - b. Hang visual display units on rail support system.
 2. Modular Support System: Install adjustable standards in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Install standards at **48 inches (1219 mm)** o.c., vertically aligned and plumb, and attached to wall surface with fasteners at **12 inches (300 mm)** o.c.
 - a. Mounting Height: **12 inches (300 mm)** above finished floor to bottom of standard.
 - b. Install single-slotted standard at each end of each run of standards and double-slotted standards at intermediate locations.
 - c. Provide locking screw at top corner of visual display board at each standard.
 - d. Hang visual display units on modular support system.
- I. Installation Of Factory-Fabricated Visual Display Units
1. Sliding Visual Display Units: Install units in recessed locations and at mounting heights indicated. Attach to wall framing with fasteners at not more than **16 inches (400 mm)** o.c.
 - a. Adjust panels to operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.
 2. Visual Display Conference Units: Install units in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners through back of cabinet **OR** concealed brackets screwed to wall **OR** concealed wood cleats screwed to wall, **as directed**.
 - a. Mounting Height: **72 inches (1829 mm)** above finished floor to top of cabinet.
- J. Installation Of Visual Display Wall Covering
1. General: Comply with visual display wall covering manufacturers' written installation instructions.
 2. Install seams horizontal and level, with lowest seam **24 inches (610 mm)** above finished floor. Railroad fabric (reverse roll direction) to ensure color matching.

3. Double cut seams, with no gaps or overlaps. Remove air bubbles, wrinkles, blisters, and other defects.
 4. After installation, clean visual display wall covering according to manufacturer's written instructions. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.
- K. Installation Of Visual Electronic Markerboards
1. Electronic Markerboards: Install units in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall **OR** cubicle, **as directed**, surface with manufacturer's standard mounting hardware.
 - a. Mounting Height: **72 inches (1829 mm)** above finished floor to top of markerboard.
- L. Cleaning And Protection
1. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.
 2. Touch up factory-applied finishes to restore damaged or soiled areas.
 3. Cover and protect visual display surfaces after installation and cleaning.
- M. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain motor-operated, sliding visual display units.

END OF SECTION 10 11 16 13

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SECTION 10 22 19 13 - DEMOUNTABLE PARTITIONS

1.1 GENERAL

A. Description Of Work:

1. This specification covers the furnishing and installation of materials for demountable partitions. 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. Demountable site-assembled partitions.
 - b. Demountable unitized-panel partitions.

C. Performance Requirements

1. Structural Performance: Provide demountable partitions capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - a. Load-Bearing Capacity of Panel System: Not less than **300-lb (136-kg concentrated) OR 2.3-lb/linear inch (0.041-kg/linear mm)** distributed, **as directed**, proof load when tested according to BIFMA X 5.6, Section 6, Table 1.
 - b. Transverse-Load Capacity of Panel System: Lateral deflection of not more than 1/120 **OR 1/240, as directed**, of the overall span when tested under a uniformly distributed load of **5 lb/sq. ft. (24.4 kg/sq. m)** according to ASTM E 72.
 - c. Seismic Performance: Provide demountable partitions 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. Shop Drawings: For demountable partitions. Include plans, elevations, sections, details, and attachments to other work.
3. Samples: For each type of exposed finish required.
4. Product Test Reports.
5. Maintenance Data.

E. Quality Assurance

1. Sound Transmission Characteristics: Where STC ratings are indicated, provide partitions with STC rating that was determined by testing an identical system according to ASTM E 90 and classified according to ASTM E 413 by a qualified independent testing agency.
2. Fire-Test-Response Characteristics: Provide demountable partitions complying with the following requirements:
 - a. Where indicated, provide demountable partitions identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or a testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1) Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
 - b. Surface-Burning Characteristics: Provide demountable partitions per ASTM E 84:
 - 1) Flame-Spread Index: 25 or less.
 - 2) Smoke-Developed Index: 450 or less.
3. Fire-Rated Door and Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated.
 - a. Test Pressure:

- 1) Test at atmospheric (neutral) pressure according to NFPA 252 or UL 10B.
OR
 Test according to NFPA 252 or UL 10C. After 5 minutes into the test, neutral pressure level in furnace shall be established at **40 inches (1016 mm)** or less above the sill.
- b. As scheduled on Drawings.
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.

1.2 PRODUCTS

A. Demountable Site-Assembled Partitions

1. Face Panels: Manufacturer's standard **OR** Gypsum board, ASTM C 36/C 36M **OR** Wood composite **OR** Fiber composite **OR** Steel-sheet-faced gypsum board, ASTM C 36/C 36M **OR** Stainless-steel-sheet-faced gypsum board, ASTM C 36/C 36M, **as directed**.
 - a. Thickness: Manufacturer's standard **OR 1/2 inch (13 mm) OR 5/8 inch (16 mm) OR 3/4 inch (19 mm), as directed**.
 - b. Width: Manufacturer's standard **OR 24 inches (610 mm) OR 30 inches (762 mm) OR** As indicated, **as directed**.
 - c. Finish: Unfinished **OR** Manufacturer's standard prime-coat finish ready for field painting **OR** Vinyl wall covering complying with CFFA-W-101-A **OR** Fabric **OR** Factory-applied paint finish **OR** Powder-coat finish **OR** No. 4 satin, **as directed**.
 - d. Colors, Textures, and Patterns: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
2. Accessory Panels: Manufacturer's standard fabric-covered tackable panels **OR** porcelain-enamel chalkboard and markerboard panels, **as directed**.
3. Framing: Studs, top and bottom track, **2-1/2 inches (64 mm) OR 4 inches (102 mm) OR** manufacturer's standard, **as directed**, deep.
 - a. Steel: Metallic-coated, **0.0359-inch (0.912-mm)** base metal thickness.
 - b. Aluminum.
 - c. Fiberglass.
4. Panel Joint Closure: Manufacturer's standard **OR** Vinyl **OR** Aluminum **OR** Steel, **as directed**.
5. Trim: Continuous, factory-finished, snap-on type; adjustable for variations in floor level **OR** floor and ceiling levels, **as directed**.
 - a. Outside Corner Trim: Square **OR** Radiused, **as directed**.
 - b. Base: Snap-on vinyl **OR** metal, **as directed**.
 - c. Base Trim Profile: Recessed **OR** Projected **OR** Flush, **as directed**.
 - d. Ceiling Trim Profile: Recessed **OR** Projected, **as directed**.
 - e. Cornice Trim: Continuous over tops of partial-height units for maximum stability.
 - f. Exposed-Metal Trim Finish: Factory-applied paint finish **OR** Clear-anodized aluminum; AAMA 611, AA-M12C22A31, Class II **OR** Color-anodized aluminum; AAMA 611, AA-M12C22A32/A34, Class II **OR** Manufacturer's standard prime-coat finish ready for field painting, **as directed**.
 - g. Trim Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
6. Doors: As specified in Division 12.
7. Door Frames: Manufacturer's standard steel **OR** aluminum, **as directed**, reversible, **as directed**, factory mortised to receive hardware, **as directed**, for **1-3/4-inch (45-mm)** doors.
 - a. Frame Finishes: Factory-applied paint finish **OR** Clear-anodized aluminum; AAMA 611, AA-M12C22A31, Class II **OR** Color-anodized aluminum; AAMA 611, AA-M12C22A32/A34, Class II **OR** Manufacturer's standard prime-coat finish ready for field painting, **as directed**.
 - b. Frame Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

8. Fire-Protection Rating of Rated Door Assemblies: Labeled 20 **OR** 45, **as directed**, minutes.
 9. Hardware: As specified in Division 08 Section "Door Hardware".
 10. Glazing Frames: Manufacturer's standard **OR** Match door frames, **as directed**, for glazing thickness indicated.
 - a. Frame Finishes: Factory-applied paint finish **OR** Clear-anodized aluminum; AAMA 611, AA-M12C22A31, Class II **OR** Color-anodized aluminum; AAMA 611, AA-M12C22A32/A34, Class II **OR** Manufacturer's standard prime-coat finish ready for field painting, **as directed**.
 - b. Frame Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
 11. Glazing: Fully tempered clear float glass **OR** Laminated clear float glass **OR** Glass type indicated, **as directed**, complying with Division 08 Section "Glazing".
 12. Acoustical Rating: STC 35, unless directed otherwise.
 13. Fire-Resistance Rating of Partition Assemblies: 1 hour.
 14. Seals: Manufacturer's standard **OR** Open cell, 2 lb/cu. ft. (32 kg/cu. m), **as directed**.
- B. Demountable Unitized-Panel Partitions
1. Panels: Manufacturer's standard **OR** Gypsum board, ASTM C 36/C 36M **OR** Wood composite **OR** Fiber composite **OR** Steel-sheet-faced gypsum board, ASTM C 36/C 36M **OR** Stainless-steel-sheet-faced gypsum board, ASTM C 36/C 36M, **as directed**.
 - a. Type: Unfinished **OR** Factory finished **OR** Metal faced, **as directed**.
 - b. Thickness: Manufacturer's standard **OR** 1-3/4 inches (45 mm) **OR** 2-1/4 inches (57 mm), **as directed**.
 - c. Width: Manufacturer's standard **OR** 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** As indicated, **as directed**.
 - d. Finish: Vinyl wall covering complying with CFFA-W-101-A **OR** Fabric **OR** Factory-applied paint finish **OR** Powder-coat finish **OR** Stainless steel, **as directed**.
 - e. Colors, Textures, and Patterns: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
 2. Accessory Panels: Manufacturer's standard fabric-covered tackable panels **OR** porcelain-enamel chalkboard and markerboard panels, **as directed**.
 3. Framing: Manufacturer's standard **OR** Steel **OR** Aluminum, **as directed**.
 - a. Frame Finishes: Factory-applied paint finish **OR** Clear-anodized aluminum; AAMA 611, AA-M12C22A31, Class II **OR** Color-anodized aluminum; AAMA 611, AA-M12C22A32/A34, Class II **OR** Manufacturer's standard prime-coat finish ready for field painting, **as directed**.
 - b. Frame Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
 4. Panel Joint Closure: Manufacturer's standard **OR** Flush **OR** Vinyl **OR** Aluminum **OR** Steel, **as directed**.
 5. Trim: Continuous, factory-finished, snap-on type; adjustable for variations in floor level **OR** floor and ceiling levels, **as directed**.
 - a. Base Trim Profile: Recessed **OR** Projected **OR** Flush, **as directed**.
 - b. Ceiling Trim Profile: Recessed **OR** Projected, **as directed**.
 - c. Cornice Trim: Continuous over tops of partial-height units for maximum stability.
 - d. Exposed-Metal Trim Finish: Factory-applied paint finish **OR** Clear-anodized aluminum; AAMA 611, AA-M12C22A31, Class II **OR** Color-anodized aluminum; AAMA 611, AA-M12C22A32/A34, Class II **OR** Manufacturer's standard prime-coat finish ready for field painting, **as directed**.
 - e. Colors: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
 6. Doors: Manufacturer's standard solid-core wood **OR** steel **OR** glazed, **as directed**, 1-3/4 inches (45 mm) thick.
 - a. Door Finishes: Factory-applied paint finish **OR** Clear-anodized aluminum; AAMA 611, AA-M12C22A31, Class II **OR** Color-anodized aluminum; AAMA 611, AA-M12C22A32/A34, Class II **OR** Manufacturer's standard prime-coat finish ready for field painting, **as directed**.
 - b. Door Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

7. Door Frames: Manufacturer's standard steel **OR** aluminum, **as directed**, reversible, **as directed**, factory mortised to receive hardware, **as directed**, for **1-3/4-inch (45-mm)** doors.
 - a. Frame Finishes: Factory-applied paint finish **OR** Clear-anodized aluminum; AAMA 611, AA-M12C22A31, Class II **OR** Color-anodized aluminum; AAMA 611, AA-M12C22A32/A34, Class II **OR** Manufacturer's standard prime-coat finish ready for field painting, **as directed**.
 - b. Frame Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
8. Hardware: As specified in Division 08 Section "Door Hardware".
9. Glazing Frames: Manufacturer's standard **OR** Match door frames, **as directed**, for glazing thickness indicated.
 - a. Frame Finishes: Factory-applied paint finish **OR** Clear-anodized aluminum; AAMA 611, AA-M12C22A31, Class II **OR** Color-anodized aluminum; AAMA 611, AA-M12C22A32/A34, Class II **OR** Manufacturer's standard prime-coat finish ready for field painting, **as directed**.
 - b. Frame Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
10. Glazing: Fully tempered clear float glass **OR** Laminated clear float glass **OR** Glass type indicated, **as directed**, complying with Division 08 Section "Glazing".
11. Acoustical Rating: STC 35, unless directed otherwise.
12. Seals: Manufacturer's standard **OR** Open cell, **2 lb/cu. ft. (32 kg/cu. m)**, **as directed**.

C. Fabrication

1. Demountable Site-Assembled Panels: Fabricate each panel from one sheet **OR** two sheets, **as directed**, of gypsum board.
 - a. Transom Panels: Fabricate in material and finish to match wall panels, unless otherwise indicated.
2. Demountable Unitized Panels: Factory-assembled, flush, hollow unit construction; with faces smooth and free of buckles, oil canning, and seams; and insulated with solidly packed, inorganic, mineral filler. Fabricate panels for installation with concealed fastening devices and pressure-fit components that will not damage ceiling or floor coverings. Fabricate panels with continuous light-and-sound seals at floor, ceiling, and other locations where panels abut fixed construction.
 - a. Factory glaze panels to the greatest extent possible.
3. Components: Fabricate components for installation with concealed fastening devices and pressure-fit members that will not damage ceiling or floor coverings. Fabricate for installation with continuous seals at floor, ceiling, and other locations where partition assemblies abut fixed construction and for installation of sound attenuation insulation in partition cavities.

D. Finishes, General

1. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2. 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. Installation

1. Install demountable partition systems rigid, level, plumb, and aligned. Install seals to prevent light and sound transmission at connections to floors, ceilings, fixed walls, and abutting surfaces.
 - a. Installation Tolerance: Install each demountable partition so surfaces vary not more than **1/8 inch (3 mm)** from the plane formed by the faces of adjacent partitions.
2. Do not alter ceiling suspension system **OR** Make alterations to ceiling suspension system required by partition installation or to gain access to electrical or communication systems without

- affecting the structural integrity of ceiling suspension system. Make alterations so they are not noticeable after panel installation, **as directed**.
3. Install door-and-frame and glazing-and-glazing-frame assemblies securely anchored to partitions and with doors aligned and fitted. Install and adjust door hardware for proper operation.
 - a. Install fire-rated door frames according to NFPA 80.

END OF SECTION 10 22 19 13

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Task	Specification	Specification Description
10 22 19 43	10 22 19 13	Demountable Partitions
10 22 19 53	10 22 19 13	Demountable Partitions

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SECTION 11 14 13 16 - TURNSTILES

1.1 GENERAL

- A. Description Of Work
 - 1. This specification covers the furnishing and installation of turnstiles. Installation procedures 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: Drawings showing individual turnstile construction, overall dimensions for installation, and installation details including trim and accessories.
 - 2. Materials List showing major components, materials and material thicknesses.
 - 3. Product Sample: Manufacturer shall demonstrate field up-gradability of the rotary gates from mechanical control to electronic control.
- C. Product Handling: Store turnstiles in a dry well ventilated place in the original crating and protective wrappings and protect all finished from damage during handling.

1.2 PRODUCTS

- A. Security Turnstiles
 - 1. Type B Rotary Gate
 - a. Mechanism: All steel and machined cast iron with two ratchets each 1-1/4" thick hardened steel. Two locking pawls 1-1/4" thick hardened steel. Automatic control with free turning one direction **OR** free turning both directions, **as directed**.
 - b. Arms: Hot dip galvanized steel tubing, wall thickness of 0.105" and 1.31" o.d.. Arm ends spun closed under heat and pressure, for a smooth safe finish. Heel guards on bottom arms of rotor "U" shaped sheet steel channels surrounding the lower arms and extending to the flooring.
 - c. Rotor and Barrier Vertical Members: 1/4" thick steel angles, hot dip galvanized. Arms pinned into rotor with malleable iron clamps. Non-welded construction.
 - d. Vertical Passage Members: Tubing with 1/8" wall thickness and 1" o.d., hot dip galvanized.
 - e. Bottom Bearing: Machined grey iron casting 1-1/2" thick, 12" diameter.
 - f. Height: As required to meet project requirements.
 - 2. Type AA Rotary Gate
 - a. Mechanism: All steel and machined cast iron. Two control ratchets each 1-1/4" thick hardened steel. Two locking pawls each 1-1/4" thick hardened steel. Automatic control with free turning one direction **OR** free turning both directions, **as directed**.
 - b. Arms: Square steel tubing, walls 0.097" thick, ends spun closed, bottom arms with heel guards.
 - c. Rotor and Barrier Columns: Five angles of 1/4" thick steel, sixty-three malleable cast iron clamps, non-welded construction.
 - d. Vertical Cage Members: 3 "U" channels 0.097" wall thickness, passage sheet 4' high by 5'2" length of 0.048" thick steel, 7 reinforcing bands of 0.38" thick steel.
 - e. Bottom Bearing: Machined grey iron casting 1-1/2" thick, 12" diameter.
 - f. Ceiling: Full round steel sheet 0.052" thick with 1" x 1" circular reinforcing angle at edge.
 - g. Height: As required to meet project requirements.
 - 3. Type SA Rotary Gate
 - a. Mechanism: All steel and machine cast iron. Two control ratchets each 1-1/4" thick hardened steel. Two locking pawls each 1-1/4" thick hardened steel. Time delay and power

- relays with 10 amp contact ratings and ten million operation life. One-way operation **OR** two-way, **as directed**, agent operated.
- b. Arms: ANSI 304 stainless steel (brushed finish); 4" reinforcing plugs at rotor end, spun closed ends, walls 0.065" thick.
 - c. Rotor: One piece solid aluminum extrusion weighing 140 lbs., three wing cross section, anodized.
 - d. Vertical Columns: One barrier support column of 3" by 3" solid aluminum, three passageway support columns of 2" by 2" aluminum tubing with 1/8" wall thickness.
 - e. Passageway Sheeting: ANSI 304 stainless steel (brushed finish) 0.065" thick **OR** 1/4" thick curved polycarbonate sheet, **as directed**, rising from 4" above floor level to 4" below mechanism housing.
 - f. Ceiling: Full ceiling 6 ft. diameter, 5" deep.
 - g. Height: As required to meet project requirements.
4. Type Dual Rotary Gate
- a. Mechanism: All steel and machine cast iron. Two control ratchets each 1.25" thick hardened steel. Two locking pawls each 1-1/4" thick hardened steel. Time delay and power relays with 10 amp contact ratings and ten million operation life. One-way operation **OR** two-way, **as directed**, agent operated.
 - b. Arms: ANSI 304 stainless steel (brushed finish); 4" reinforcing plugs at rotor end, spun closed ends, walls 0.065" thick. Press fit 3.5" into rotor sockets.
 - c. Rotors: One piece solid aluminum extrusions weighing 140 lbs. each, three wing cross section, clear anodized.
 - d. Barriers: Two columns of 2" by 2" solid aluminum, 21 arms 54" in length bent 1" o.d. ANSI 302 Tubing with 0.080" wall thickness, force fit and pin secured.
 - e. Passageway Columns: Four columns of 2" by 2" clear anodized aluminum tubing with 1/8" wall thickness.
 - f. Passageway Sheeting: ANSI 304 stainless steel (brushed finish) 0.065" thick **OR** 1/4" thick curved polycarbonate sheet, **as directed**, rising from 4" above floor level to 4" below mechanism housing.
 - g. Ceiling: Full ceiling 8' by 4'6", 5" deep.
 - h. Height: As required to meet project requirements.
5. 24" Diameter Manual Turnstiles
- a. Cover: Deep drawn ANSI #304 stainless steel (brushed finish), 0.078" thick, corners with 1-3/8" radii.
 - b. Frame: ANSI #304 stainless steel (brushed finish) **OR** painted mild steel, **as directed**. Welded double wall (cavity) construction. Each wall 0.078" thick. 2" blending outer wall radii, 1/4" thick stainless steel base plate.
 - c. Mechanical Mechanism: Ratchet of 1" x 6-1/2" machined cast iron. Use aided by springs of 0.175" diameter spring steel. Motion stabilized by large rotary shock absorber and cast iron two-lobe cam. Self centered by 1/2" steel compression shoe.
 - 1) Unlocking Controls: One continuous-duty rated 24VDC solenoid with 620% of required strength. Solenoid shall operate for 45 milliseconds per passage. All unlocking elements shall be mechanical. No time relays or transformers.
 - 2) Mechanism shall be field upgradable from mechanical counting to electronic counting both local and remote, without cutting, filing or other structural modifications. Mechanism shall be field upgradable from mechanical unlocking control to electronic unlocking control, both single passage and escrow control, without cutting, filing or other structural modifications.
 - d. Arms: ANSI #304 stainless steel tubing (brushed finish), 0.049" thick walls, spun closed ends. Arms shall be press fit into grey cast iron hub and held to main shaft with drill rod taper pin.
 - e. Hub: Grey cast iron, taper pin mounting.
 - f. Portable: 0.063" thick machined cast iron floor tread, force fit ANSI #304 stainless steel railing (brushed finish), with 0.0112" wall thickness hand-grip loops, 3-1/2" diameter solid rubber wheels recessed into cabinet.

1.3 EXECUTION:

- A. Installation: Install turnstiles in accordance with manufacturer's instructions.

END OF SECTION 11 14 13 16

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Task	Specification	Specification Description
11 14 13 19	11 14 13 16	Turnstiles

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SECTION 11 52 13 13 - PROJECTION SCREENS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for projection screens. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Manually operated projection screens.
 - b. Electrically operated projection screens and controls.
 - c. Rigid rear-projection screens.

C. Definitions

1. Gain of Front-Projection Screens: Ratio of light reflected from screen material to that reflected perpendicularly from a magnesium carbonate surface as determined per SMPTE RP 94.
2. Gain of Rear-Projection Screens: Ratio of light refracted by screen material to that reflected perpendicularly from a magnesium carbonate surface as determined per SMPTE RP 94, except that for measuring luminance of test screen, projection lamp shall be placed behind screen same distance as it was placed in front of magnesium carbonate surface for measuring luminance of reference standard.
3. Half-Gain Angle: The angle, measured from the axis of the screen surface to the most central position on a perpendicular plane through the horizontal centerline of the screen where the gain is half of the peak gain.

D. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: For projection screens. Show layouts and types of projection screens. Include the following:
 - a. For manually operated projection screens:
 - 1) Drop lengths.
 - 2) Anchorage details.
 - 3) Accessories.
 - b. For electrically operated projection screens and controls:
 - 1) Location of screen centerline relative to ends of screen case.
 - 2) Location of wiring connections for electrically operated units.
 - 3) Location of seams in viewing surfaces.
 - 4) Drop lengths.
 - 5) Anchorage details, including connection to supporting structure for suspended units.
 - 6) Details of juncture of exposed surfaces with adjacent finishes.
 - 7) Accessories.
 - 8) Wiring diagrams.
 - c. For rigid rear-projection screens:
 - 1) Frame details.
 - 2) Anchorage details.
 - 3) Details of juncture of exposed surfaces with adjacent finishes.
 - 4) Accessories.
3. Maintenance Data: For projection screens to include in maintenance manuals.

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.

F. Delivery, Storage, And Handling

1. Environmental Limitations: Do not deliver or install projection screens until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Store rear-projection screens in manufacturer's protective packaging and according to manufacturer's written instructions.

1.2 PRODUCTS

A. Manually Operated Projection Screens

1. General: Manufacturer's standard spring-roller-operated units, consisting of case, screen, mounting accessories, and other components necessary for a complete installation.
 - a. Screen Mounting: Top edge securely anchored to a **3-inch- (75-mm-)** diameter, rigid steel roller; bottom edge formed into a pocket holding a tubular metal slat, with ends of slat protected by plastic caps, and with a saddle and pull attached to slat by screws.
 - b. Tab Tensioning: Provide units that have a durable low-stretch cord, such as braided polyester, on each side of screen connected to edge of screen by tabs to pull screen flat horizontally. In lieu of tab tensioning, screens may be constructed from vinyl-coated screen cloth that contains horizontal stiffening monofilaments to resist edge curling, **as directed**.
2. Bracket-Mounted or Ceiling-Suspended, Metal-Encased, Manually Operated Screens: Units designed and fabricated for suspending from wall brackets or ceiling, fabricated from formed-steel sheet not less than **0.027 inch (0.7 mm)** thick or from aluminum extrusions; with vinyl covering or baked-enamel finish and matching end caps. Provide mounting brackets unless otherwise indicated.
3. Surface-Mounted, Metal-Encased, Manually Operated Screens: Units designed and fabricated for surface mounting on wall or ceiling, fabricated from formed-steel sheet not less than **0.027 inch (0.7 mm)** thick or from aluminum extrusions; with flat back design and vinyl covering or baked-enamel finish. Provide units with matching end caps and concealed mounting.
4. Surface-Mounted, Wood-Finished, Manually Operated Screens: Units designed and fabricated for surface mounting on wall or ceiling; with flat back design, hardwood finish, and concealed mounting brackets.
 - a. Hardwood: Oak **OR** Walnut **OR** Cherry **OR** As selected from manufacturer's full range of species, **as directed**.
 - b. Finish: As selected from manufacturer's full range.

B. Electrically Operated Projection Screens

1. General: Manufacturer's standard units consisting of case, screen, motor, controls, mounting accessories, and other components necessary for a complete installation. Provide units that are listed and labeled as an assembly by UL or another testing and inspecting agency acceptable to authorities having jurisdiction, **as directed**.
 - a. Controls: Remote, key-operated, **as directed**, three-position control switch installed in recessed device box with flush cover plate matching other electrical device cover plates in room where switch is installed.
 - 1) Provide two **OR** three, **as directed**, control switches for each screen.
 - 2) Provide number of control switches indicated for each screen.
 - 3) Provide power supply for low-voltage systems if required.
 - 4) Provide locking cover plates for switches.
 - 5) Provide key-operated, power-supply switch.

- 6) Provide infrared **OR** radio-frequency, **as directed**, remote control consisting of battery-powered transmitter and receiver.
- 7) Provide video interface control for connecting to projector. Projector provides signal to raise or lower screen.
- b. Motor in Roller: Instant-reversing motor of size and capacity recommended by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Mount motor inside roller with vibration isolators to reduce noise transmission.
- c. End-Mounted Motor: Instant-reversing, gear-drive motor of size and capacity recommended by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Locate motor in its own compartment on right end of screen unless otherwise indicated **OR** on left end of screen unless otherwise indicated **OR** on end of screen indicated, **as directed**.
- d. Screen Mounting: Top edge securely anchored to rigid metal roller and bottom edge formed into a pocket holding a **3/8-inch- (9.5-mm-)** diameter metal rod with ends of rod protected by plastic caps.
 - 1) Roller for end-mounted motor supported by self-aligning bearings in brackets.
 - 2) Roller for motor in roller supported by vibration- and noise-absorbing supports.
- e. Tab Tensioning: Provide units that have a durable low-stretch cord, such as braided polyester, on each side of screen connected to edge of screen by tabs to pull screen flat horizontally. In lieu of tab tensioning, screens may be constructed from vinyl-coated screen cloth that contains horizontal stiffening monofilaments to resist edge curling.
2. Surface-Mounted, Metal-Encased, Electrically Operated Screens: Motor-in-roller **OR** End-mounted motor, **as directed**, units designed and fabricated for surface mounting on wall or ceiling, fabricated from formed-steel sheet not less than **0.027 inch (0.7 mm)** thick or from aluminum extrusions; with flat back design and vinyl covering or baked-enamel finish. Provide with matching end caps and concealed mounting.
3. Surface-Mounted, Wood-Finished, Electrically Operated Screens: Motor in roller units designed and fabricated for surface mounting on wall or ceiling; with flat back design, hardwood finish, and concealed mounting brackets.
 - a. Hardwood: Oak **OR** Walnut **OR** Cherry **OR** As selected from manufacturer's full range of species, **as directed**.
 - b. Finish: As selected from manufacturer's full range.
4. Suspended, Electrically Operated Screens without Ceiling Closure: Motor-in-roller **OR** End-mounted motor, **as directed**, units designed and fabricated for suspended mounting, with bottom of case entirely or partially open under screen compartment.
 - a. Provide metal or metal-lined motor enclosure on units with end-mounted motor.
 - b. Provide metal or metal-lined wiring compartment on units with motor in roller.
 - c. Screen Case: Made from metal **OR** metal and fire-retardant materials **OR** metal, wood, wood products, and fire-retardant materials, **as directed**.
 - d. Provide screen case with trim flange to receive ceiling finish **OR** constructed to be installed with underside flush with ceiling **OR** constructed to be installed with ceiling finish applied to underside, **as directed**.
 - e. Finish on Exposed Surfaces: Prime painted **OR** Vinyl covering or baked enamel, **as directed**.
5. Suspended, Electrically Operated Screens with Automatic Ceiling Closure: Motor-in-roller **OR** End-mounted motor, **as directed**, units designed and fabricated for suspended mounting; with bottom of case composed of two panels, fully enclosing screen, motor, and wiring; one panel hinged and designed to open and close automatically when screen is lowered and fully raised, the other removable or openable for access to interior of case.
 - a. Provide metal or metal-lined motor enclosure on units with end-mounted motor.
 - b. Provide metal or metal-lined wiring compartment on units with motor in roller.
 - c. Screen Case: Made from metal **OR** metal and fire-retardant materials **OR** metal, wood, wood products, and fire-retardant materials, **as directed**.

- d. Provide screen case with trim flange to receive ceiling finish **OR** constructed to be installed with underside flush with ceiling **OR** constructed to be installed with ceiling finish applied to underside, **as directed**.
- e. Finish on Exposed Surfaces: Prime painted **OR** Vinyl covering or baked enamel, **as directed**.

C. Front-Projection Screen Material

1. Matte-White Viewing Surface: Peak gain not less than 0.9, and gain not less than 0.8 at an angle of 50 degrees from the axis of the screen surface.
2. Matte-Gray Viewing Surface: Peak gain not less than 0.8, and half-gain angle of not less than 50 degrees from the axis of the screen surface.
3. Glass-Beaded Viewing Surface: Peak gain not less than 2.0, and half-gain angle of at least 15 degrees from the axis of the screen surface.
4. Matte Reflective Viewing Surface: Peak gain not less than 1.3, and half-gain angle of at least 40 degrees from the axis of the screen surface.
5. Wide-Angle Reflective Viewing Surface: Peak gain not less than 1.5, and half-gain angle of at least 35 degrees from the axis of the screen surface.
6. Multipurpose Reflective Viewing Surface: Peak gain not less than 1.8, and half-gain angle of at least 25 degrees from the axis of the screen surface.
7. High-Gain Reflective Viewing Surface: Peak gain not less than 2.5, and half-gain angle of at least 20 degrees from the axis of the screen surface.
8. Material: Vinyl-coated, glass-fiber fabric or vinyl sheet.
9. Mildew-Resistance Rating: 0 or 1 when tested according to ASTM G 21.
10. Flame Resistance: Passes NFPA 701.
11. Flame-Spread Index: Not greater than 75 when tested according to ASTM E 84.
12. Seams: Where length of screen indicated exceeds maximum length produced without seams in material specified, provide screen with horizontal seam placed as follows:
 - a. At top **OR** bottom, **as directed**, of screen at juncture between extra drop length and viewing surface.
 - b. In location indicated.
13. Seamless Construction: Provide screens, in sizes indicated, without seams.
14. Edge Treatment: Black **OR** Without black, **as directed**, masking borders.
15. Size of Viewing Surface: **50 by 50 inches (1270 by 1270 mm) OR 60 by 60 inches (1524 by 1524 mm) OR 70 by 70 inches (1778 by 1778 mm) OR 84 by 84 inches (2133 by 2133 mm) OR 48 by 65 inches (1219 by 1651 mm) OR 54 by 72 inches (1371 by 1828 mm) OR 58 by 79 inches (1473 by 2006 mm) OR 72 by 96 inches (1828 by 2438 mm), as directed.**
16. Provide extra drop length of dimensions and at locations indicated.
 - a. Color: Same as viewing surface **OR** Black, **as directed**.

D. Flexible Rear-Projection Screen Material

1. Wide-Angle Screens: Peak gain not less than 1.0, and half-gain angle of at least 35 degrees from the axis of the screen surface.
2. Moderate-Gain Screens: Peak gain not less than 1.3, and half-gain angle of at least 30 degrees from the axis of the screen surface.
3. High-Gain Screens: Peak gain not less than 1.8, and half-gain angle of at least 15 degrees from the axis of the screen surface.
4. Material: Coated vinyl sheet.
5. Mildew-Resistance Rating: 0 or 1 when tested according to ASTM G 21.
6. Flame Resistance: Passes NFPA 701.
7. Flame-Spread Index: Not greater than 75 when tested according to ASTM E 84.
8. Seamless Construction: Provide screens, in sizes indicated, without seams.
9. Size of Viewing Surface: **50 by 50 inches (1270 by 1270 mm) OR 60 by 60 inches (1524 by 1524 mm) OR 70 by 70 inches (1778 by 1778 mm) OR 84 by 84 inches (2133 by 2133 mm) OR 48 by 65 inches (1219 by 1651 mm) OR 54 by 72 inches (1371 by 1828 mm) OR 58 by 79 inches (1473 by 2006 mm) OR 72 by 96 inches (1828 by 2438 mm), as directed.**

10. Provide extra drop length of dimensions and at locations indicated.
 - a. Color: Same as viewing surface **OR** Black, **as directed**.
- E. Optically Coated Rigid Rear-Projection Screens
1. Screen Substrate: Optically clear substrate complying with the following requirements:
 - a. Clear float glass complying with ASTM C 1036 for Type I (transparent glass, flat), Class 1 (clear), and Quality q3 (glazing select), 6.0 mm thick **OR** 10.0 mm thick **OR** 12.0 mm thick **OR** thickness as indicated, **as directed**.
 - b. Colorless, transparent, cast-acrylic sheet with a luminous transmittance of 92 percent per ASTM D 1003 and complying with ASTM D 4802, Category A-1 (cell cast), Finish 1 (smooth or polished), **1/4 inch (6.4 mm) thick OR 3/8 inch (9.5 mm) thick OR 1/2 inch (12.7 mm) thick OR** thickness as indicated, **as directed**.
 - c. Fresnel lens cast from colorless, transparent, acrylic with a luminous transmittance of 92 percent per ASTM D 1003 and complying with ASTM D 4802, Category A-1 (cell cast), Finish 1 (smooth or polished) on one side and Finish 2 (patterned) on other side, **1/4 inch (6.4 mm) thick OR 3/8 inch (9.5 mm) thick OR 1/2 inch (12.7 mm) thick OR** thickness as indicated, **as directed**.
 2. Optical Coating: Durable, washable coating bonded to one side of substrate.
 3. Wide-Angle Screens: Peak gain not less than 1.0, and half-gain angle of at least 35 degrees from the axis of the screen surface.
 4. Moderate-Gain Screens: Peak gain not less than 1.3, and half-gain angle of at least 30 degrees from the axis of the screen surface.
 5. General-Purpose Screens: Peak gain of not less than 1.8, and half-gain angle of at least 28 degrees from the axis of the screen surface.
 6. High-Gain Screens: Peak gain not less than 2.0, and half-gain angle of at least 20 degrees from the axis of the screen surface.
 7. Optical Tint: High-contrast dark gray **OR** Medium neutral gray **OR** Neutral white **OR** Manufacturer's standard, **as directed**.
 8. Protective Coating: Provide formulation designed by screen manufacturer as a permanent topcoat over optical coatings to protect against normal abrasion before, during, and after installation.
 9. Writing-Surface Coating: Provide screen manufacturer's protective coating, designed as a writing surface for dry-erase markers, on front of screen.
 10. Size of Viewing Surface: **40 by 54 inches (1016 by 1371 mm) OR 43 by 57 inches (1092 by 1447 mm) OR 50 by 67 inches (1270 by 1701 mm) OR 54 by 72 inches (1371 by 1828 mm) OR 60 by 80 inches (1524 by 2032 mm) OR 72 by 96 inches (1828 by 2438 mm), as directed.**
- F. High-Performance Rigid Rear-Projection Screens
1. High-Performance Screens, General: Acrylic screen with Fresnel lens on rear surface and linear lenses on front surface.
 - a. Screen Substrate: Optically clear acrylic with a luminous transmittance of 92 percent per ASTM D 1003 and complying with ASTM D 4802, Category A-1 (cell cast), Finish 2 (patterned), **1/4 inch (6.4 mm) thick OR 3/8 inch (9.5 mm) thick OR 1/2 inch (12.7 mm) thick OR** thickness as indicated, **as directed**.
 2. Performance:
 - a. Peak gain not less than 3.0 **OR** 4.0, **as directed**, and horizontal half-gain angle of at least 50 degrees from the axis of the screen surface.
 - b. Peak gain of 3.5 **OR** 4.0, **as directed**, and horizontal half-gain angle of at least 30 degrees from the axis of the screen surface.
 - c. Performance: Peak gain of 5.0, and horizontal half-gain angle of at least 25 degrees from the axis of the screen surface.
 - d. Performance: Peak gain not less than 1.5 **OR** 3.0, **as directed**, and horizontal half-gain angle of at least 20 degrees from the axis of the screen surface.
 3. Size of Viewing Surface: **40 by 54 inches (1016 by 1371 mm) OR 43 by 57 inches (1092 by 1447 mm) OR 50 by 67 inches (1270 by 1701 mm) OR 54 by 72 inches (1371 by 1828 mm) OR 60 by 80 inches (1524 by 2032 mm) OR 72 by 96 inches (1828 by 2438 mm), as directed.**

G. Rigid Rear-Projection Screen Accessories

1. Factory Frames: Screen manufacturer's standard frames of profile indicated, fabricated to sizes required to fit screens from aluminum extrusions complying with **ASTM B 221** (**ASTM B 221M**) for 6063-T5 alloy and temper.
 - a. Class II, Clear Anodic Finish: AA-M12C22A41 (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.
 - b. Class II, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker) complying with AAMA 611.
 - 1) Color: Black **OR** Dark bronze **OR** Either black or dark bronze, as standard with manufacturer, **as directed**.
2. Glazing Accessories for Factory Frames: Provide gaskets and setting blocks with proven record of compatibility with screen and frame surfaces, of sizes and shapes to accommodate thickness of screen indicated and to fit glazing channel provided.
3. Glazing Accessories for Field-Framed Screens: Provide materials compatible with screen and frame surfaces while complying with applicable requirements in Division 08 Section "Glazing".

1.3 EXECUTION

A. Front-Projection Screen Installation

1. Install front-projection screens at locations indicated to comply with screen manufacturer's written instructions.
2. Install front-projection screens with screen cases in position and in relation to adjoining construction indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.
 - a. Install low-voltage controls according to NFPA 70 and complying with manufacturer's written instructions.
 - 1) Wiring Method: Install wiring in raceway except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
 - b. Test electrically operated units to verify that screen controls, limit switches, closures, and other operating components are in optimum functioning condition.
 - c. Test manually operated units to verify that screen-operating components are in optimum functioning condition.

B. Rigid Rear-Projection Screen Installation

1. Install rear-projection screens at locations indicated to comply with screen manufacturer's written instructions. Handle screens carefully during installation using procedures and tools recommended by screen manufacturer; do not abrade screen surfaces.
2. Install optically coated rear-projection screens with optical coating toward projector **OR** audience, **as directed**.
3. Install high-performance, rear-projection screens with orientation as indicated in manufacturer's written instructions.
4. Install factory-framed, rear-projection screens in prepared wall openings. Securely anchor frames to surrounding construction so frames are plumb and level and screen surfaces are flat.
5. Install rear-projection screens with glass substrates, in frames specified in other Sections, to comply with applicable requirements in Division 08 Section "Glazing" and with screen manufacturer's written instructions. Set projection screen with surfaces flat and edges plumb and level.

6. Install rear-projection screens with plastic substrates, in frames specified in other Sections, to comply with screen manufacturer's written instructions. Clamp units only at top edge and allow for expansion and contraction of plastic glazing material by providing frame with adequate bite and edge clearances.
- C. Protecting And Cleaning Rigid Rear-Projection Screens
1. Provide temporary covering of rear-projection screens until time of Final Completion. Use type of covering approved by screen manufacturer that will effectively protect screen from abrasion, breakage, or other damage.
 2. Clean rear-projection screens on both faces immediately before date scheduled for inspection intended to establish date of Final Completion. Use methods and cleaning materials recommended by screen manufacturer, taking care not to scratch or damage optical coatings or screen substrates.
- D. Projection Screen Schedule
1. Manually Operated, Front-Projection Screen Type: Surface mounted, metal encased **OR** Surface mounted, wood finished, **as directed**.
 - a. Screen Surface: Matte white **OR** Matte gray **OR** Glass beaded **OR** Matte reflective **OR** Wide-angle reflective **OR** Multipurpose reflective **OR** High-gain reflective, **as directed**.
 - b. Viewing Surface Size: 50 by 50 inches (1270 by 1270 mm) **OR** 60 by 60 inches (1524 by 1524 mm) **OR** 70 by 70 inches (1778 by 1778 mm) **OR** 84 by 84 inches (2133 by 2133 mm) **OR** 48 by 65 inches (1219 by 1651 mm) **OR** 54 by 72 inches (1371 by 1828 mm) **OR** 58 by 79 inches (1473 by 2006 mm) **OR** 72 by 96 inches (1828 by 2438 mm), **as directed**.
 - c. Extra Drop Length: As needed at top of screen for bottom of screen to be 36 inches (900 mm) above floor and 36 inches (900 mm) at bottom of screen, **as directed**.
 2. Electrically Operated, Front-Projection Screen Type: Surface mounted, metal encased **OR** Surface mounted, wood finished **OR** Suspended, without ceiling closure **OR** Suspended, with automatic ceiling closure, **as directed**.
 - a. Motor Configuration: Motor in roller **OR** End-mounted motor on right end of screen **OR** End-mounted motor on left end of screen **OR** End-mounted motor on end of screen indicated, **as directed**.
 - b. Screen Surface: Matte white **OR** Matte gray **OR** Glass beaded **OR** Matte reflective **OR** Wide-angle reflective **OR** Multipurpose reflective **OR** High-gain reflective, **as directed**.
 - c. Viewing Surface Size: 50 by 50 inches (1270 by 1270 mm) **OR** 60 by 60 inches (1524 by 1524 mm) **OR** 70 by 70 inches (1778 by 1778 mm) **OR** 84 by 84 inches (2133 by 2133 mm) **OR** 48 by 65 inches (1219 by 1651 mm) **OR** 54 by 72 inches (1371 by 1828 mm) **OR** 58 by 79 inches (1473 by 2006 mm) **OR** 72 by 96 inches (1828 by 2438 mm), **as directed**.
 - d. Extra Drop Length: As needed at top of screen for bottom of screen to be 36 inches (900 mm) above floor and 36 inches (900 mm) at bottom of screen, **as directed**.
 3. Manually Operated, Rear-Projection Screen Type: Surface mounted, metal encased **OR** Surface mounted, wood finished, **as directed**.
 - a. Screen Type: Wide angle **OR** Moderate gain **OR** High gain, **as directed**.
 - b. Viewing Surface Size: 50 by 50 inches (1270 by 1270 mm) **OR** 60 by 60 inches (1524 by 1524 mm) **OR** 70 by 70 inches (1778 by 1778 mm) **OR** 84 by 84 inches (2133 by 2133 mm) **OR** 48 by 65 inches (1219 by 1651 mm) **OR** 54 by 72 inches (1371 by 1828 mm) **OR** 58 by 79 inches (1473 by 2006 mm) **OR** 72 by 96 inches (1828 by 2438 mm), **as directed**.
 - c. Extra Drop Length: As needed at top of screen for bottom of screen to be 36 inches (900 mm) above floor and 36 inches (900 mm) at bottom of screen, **as directed**.
 4. Electrically Operated, Rear-Projection Screen Type: Surface mounted, metal encased **OR** Surface mounted, wood finished **OR** Suspended, without ceiling closure **OR** Suspended, with automatic ceiling closure, **as directed**.
 - a. Motor Configuration: Motor in roller **OR** End-mounted motor on right end of screen **OR** End-mounted motor on left end of screen **OR** End-mounted motor on end of screen indicated, **as directed**.
 - b. Screen Type: Wide angle **OR** Moderate gain **OR** High gain, **as directed**.

- c. Viewing Surface Size: **50 by 50 inches** (1270 by 1270 mm) **OR** **60 by 60 inches** (1524 by 1524 mm) **OR** **70 by 70 inches** (1778 by 1778 mm) **OR** **84 by 84 inches** (2133 by 2133 mm) **OR** **48 by 65 inches** (1219 by 1651 mm) **OR** **54 by 72 inches** (1371 by 1828 mm) **OR** **58 by 79 inches** (1473 by 2006 mm) **OR** **72 by 96 inches** (1828 by 2438 mm), **as directed**.
- d. Extra Drop Length: As needed at top of screen for bottom of screen to be **36 inches** (900 mm) above floor and **36 inches** (900 mm) at bottom of screen, **as directed**.
- 5. Rigid Rear-Projection Screen Type: Optically coated screen.
 - a. Screen Substrate: Glass **OR** Acrylic, **as directed**.
 - b. Screen Type: Wide angle **OR** Moderate gain **OR** General purpose **OR** High gain, **as directed**.
 - c. Optical Tint: High-contrast dark gray **OR** Medium neutral gray **OR** Neutral white, **as directed**.
 - d. Size of Viewing Surface: **40 by 54 inches** (1016 by 1371 mm) **OR** **43 by 57 inches** (1092 by 1447 mm) **OR** **50 by 67 inches** (1270 by 1701 mm) **OR** **54 by 72 inches** (1371 by 1828 mm) **OR** **60 by 80 inches** (1524 by 2032 mm) **OR** **72 by 96 inches** (1828 by 2438 mm), **as directed**.
 - e. Additional Features: Protective coating **OR** Writing surface coating **OR** Factory frame, **as directed**.
- 6. Rigid Rear-Projection Screen Type: High-performance screen.
 - a. Gain: Not less than 1.5 **OR** 3 **OR** 3.5 **OR** 4 **OR** 5, **as directed**.
 - b. Horizontal Half-Gain Angle: At least 20 **OR** 25 **OR** 30 **OR** 50, **as directed**, degrees from screen axis.
 - c. Size of Viewing Surface: **40 by 54 inches** (1016 by 1371 mm) **OR** **43 by 57 inches** (1092 by 1447 mm) **OR** **50 by 67 inches** (1270 by 1701 mm) **OR** **54 by 72 inches** (1371 by 1828 mm) **OR** **60 by 80 inches** (1524 by 2032 mm) **OR** **72 by 96 inches** (1828 by 2438 mm), **as directed**.
 - d. Additional Features: Factory frame.

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Task	Specification	Specification Description
11 52 13 13	01 22 16 00	No Specification Required
11 52 16 26	01 22 16 00	No Specification Required

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Task	Specification	Specification Description
21 22 16 00	01 22 16 00	No Specification Required

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SECTION 26 05 00 00 - COMMON WORK RESULTS FOR ELECTRICAL

1.1 GENERAL

- A. Description Of Work
 - 1. This specification covers the furnishing and installation of materials for common work results for electrical. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Electrical equipment coordination and installation.
 - b. Sleeves for raceways and cables.
 - c. Sleeve seals.
 - d. Grout.
 - e. Common electrical installation requirements.
- C. Definitions
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.
- D. Submittals
 - 1. Product Data: For sleeve seals.

1.2 PRODUCTS

- A. Sleeves For Raceways And Cables
 - 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.
 - a. Minimum Metal Thickness:
 - 1) For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - 2) For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).
- B. Sleeve Seals
 - 1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or 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.

C. Grout

1. 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.

1.3 EXECUTION

A. Common Requirements For Electrical Installation

1. Comply with NECA 1.
2. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
3. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
4. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
5. Right of Way: Give to piping systems installed at a required slope.

B. Sleeve Installation For Electrical Penetrations

1. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
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. 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.
5. Cut sleeves to length for mounting flush with both surfaces of walls.
6. Extend sleeves installed in floors **2 inches (50 mm)** above finished floor level.
7. Size pipe sleeves to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and raceway or cable, unless indicated otherwise.
8. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - a. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
9. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".
10. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".
11. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
12. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel **OR** cast-iron, **as directed**, pipe 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.
13. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for **1-inch (25-mm)** annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

C. Sleeve-Seal Installation

1. Install to seal exterior wall penetrations.
2. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve

seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

D. Firestopping

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

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SECTION 26 05 19 16 - COMMON WORK RESULTS FOR COMMUNICATIONS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for common work results for communications. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Communications equipment coordination and installation.
 - b. Sleeves for pathways and cables.
 - c. Sleeve seals.
 - d. Grout.
 - e. Common communications installation requirements.

C. Definitions

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

D. Submittals

1. Product Data: For sleeve seals.

1.2 PRODUCTS

A. Sleeves For Pathways And Cables

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.
 - a. Minimum Metal Thickness:
 - 1) For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - 2) For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

B. Sleeve Seals

1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or 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 pathway 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.

C. Grout

1. 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.

1.3 EXECUTION

A. Common Requirements For Communications Installation

1. Comply with NECA 1.
2. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
3. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
4. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
5. Right of Way: Give to piping systems installed at a required slope.

B. Sleeve Installation For Communications Penetrations

1. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
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. 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.
5. Cut sleeves to length for mounting flush with both surfaces of walls.
6. Extend sleeves installed in floors **2 inches (50 mm)** above finished floor level.
7. Size pipe sleeves to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and pathway or cable, unless indicated otherwise.
8. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - a. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
9. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".
10. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".
11. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
12. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel **OR** cast-iron, **as directed**, pipe 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.
13. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for **1-inch (25-mm)** annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

C. Sleeve-Seal Installation

1. Install to seal exterior wall penetrations.
2. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve

seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

D. Firestopping

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

END OF SECTION 26 05 19 16

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SECTION 26 05 19 16a - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

1.1 GENERAL

- A. Description Of Work
 - 1. This specification covers the furnishing and installation of materials for common work results for electronic safety and security. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Electronic safety and security equipment coordination and installation.
 - b. Sleeves for raceways and cables.
 - c. Sleeve seals.
 - d. Grout.
 - e. Common electronic safety and security installation requirements.
- C. Definitions
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.
- D. Submittals
 - 1. Product Data: For sleeve seals.

1.2 PRODUCTS

- A. Sleeves For Raceways And Cables
 - 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.
 - a. Minimum Metal Thickness:
 - 1) For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - 2) For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).
- B. Sleeve Seals
 - 1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or 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.

C. Grout

1. 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.

1.3 EXECUTION

A. Common Requirements For Electronic Safety And Security Installation

1. Comply with NECA 1.
2. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
3. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
4. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
5. Right of Way: Give to piping systems installed at a required slope.

B. Sleeve Installation For Electronic Safety And Security Penetrations

1. Electronic safety and security penetrations occur when raceways, pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
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. 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.
5. Cut sleeves to length for mounting flush with both surfaces of walls.
6. Extend sleeves installed in floors **2 inches (50 mm)** above finished floor level.
7. Size pipe sleeves to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and raceway or cable, unless indicated otherwise.
8. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - a. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
9. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".
10. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".
11. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
12. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel **OR** cast-iron, **as directed**, pipe 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.
13. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for **1-inch (25-mm)** annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

C. Sleeve-Seal Installation

1. Install to seal exterior wall penetrations.

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2. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- D. Firestopping
1. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping".

END OF SECTION 26 05 19 16a

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SECTION 26 05 19 16b - ELECTRICAL RENOVATION

1.1 DESCRIPTION OF WORK

- A. This specification covers the furnishing and installation of materials for electrical 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: Comply with following:
 - a. Electrical: National Fire Protection Association (NFPA): NFPA 70 - National Electrical Code (NEC).
 - b. Accessibility:
 - 1) Architectural Barriers Act of 1968 as amended (42 USC 4151-4157) 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) (42 USC §§ 12101, et seq.) and implementing regulations (28 CFR Part 35).
- B. Project Conditions
1. Existing Conditions: Buildings will be occupied during construction. See Division 1 Section "Summary of Work." Do not interfere with use of occupied portions of building. Maintain free and safe passage to and from occupied areas.
- C. Scheduling And Sequencing
1. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.
- D. Alterations, Cutting And Protection
1. Protection: Protect existing finishes, equipment, utilities and adjacent work, which is scheduled to remain, from damage.
 2. Existing Operating Facilities: Confine operations to immediate vicinity of new work and do not interfere with or obstruct ingress or egress to and from adjacent facilities.

1.3 PRODUCTS

- A. Materials
1. Electrical Materials and Devices: Comply with NFPA 70 (NEC):
 - a. Boxes: Galvanized steel, not less than 1.6 mm (0.0625 inch) thickness (NEC 370-20) grounded in accordance with NEC, Article 250, suitable for recess mounting.
 - 1) Provide boxes of appropriate shape and size for intended purpose.
 - b. Devices:
 - 1) Duplex Receptacles: 15 A or 20 A 115 V, UL Listed with screw side connections and corrugated bearing pads.
 - a) GFI Outlets: 115 V, 60 Hz, 15/20 A rating, UL Listed.
 - 2) Switches: 15 A, 115 V, single pole, single throw switch, UL Listed, with side screw connections and corrugated bearing pads.

- a) Garbage Disposal: Heavy duty, 120/277 VAC, 60 Hz, single pole, single throw, 20 A rate, UL listed and CSA certified.
 - 3) Cover Plates: Smooth plastic in color to match existing.
- c. Wiring: Insulated wire, Type NM 600 V with ground wire, sized as appropriate for intended purpose and in accordance with NEC.
 - 1) Aluminum Wire: Not allowed unless existing wiring is aluminum.
 - 2) Provide necessary fittings in accordance with NEC.

1.4 EXECUTION

A. Examination

1. Units, Spaces and Areas to be Renovated: Inspect to become familiar with existing conditions and to take measurements which are necessary for renovation work to be completed in accordance with contract requirements.
 - a. Carefully inspect condition of existing spaces including, but not limited to walls, floors, plumbing, electrical, etc. as essential to successful completion of renovation work.
 - b. Survey each space and verify dimensions for work.

B. Preparation

1. Building Occupation: Carry out renovation work to cause as little inconvenience to occupants as possible. See Division 1 Section "Summary of Work."
2. Protection: Protect and be responsible for existing buildings, facilities, utilities, and improvements within areas of construction operations.
 - a. Tenant's Property: Be responsible for any damage or loss to residents' property and to other work. Replace any material, which, in opinion of the Owner, has become damaged to extent that it could not be restored to its original condition.
 - b. Take precautions to protect residents and public from injury from construction operations.

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. Location Of Equipment And Piping

1. Drawings (if any) indicating location of equipment, piping, ductwork, etc. are diagrammatic and job conditions shall not always permit their installation in location shown. When this situation occurs, bring condition to the Owner's attention immediately. Relocation will be determined in joint conference.
2. Contractor: Do not relocate any items without first obtaining the Owner's acceptance. Remove and relocate such relocated items at own expense if so directed.

E. Electrical Work

1. General: Install boxes, wiring, and devices as indicated and required to connect and control electrical devices in accordance with NFPA 70 (NEC).
 - a. Boxes: Solidly anchor to framing or blocking.
2. Removing Electrical Switch or Duplex Outlet (Non-Hazardous Locations):
 - a. Box to Remain:
 - 1) Remove electrical device; cap hot and neutral with set-screw wire connectors.

- 2) Attach ground wire to remaining box with solid screw attachment.
 - 3) Provide and install natural finish aluminum blank cover plate with screw fasteners integral to match size of box remaining.
 - b. Box to be removed:
 - 1) Remove electrical device and box and pull wire out of wall back to first circuit panel, disconnecting from circuit panel.
 - 2) Patch and repair hole in partition to match existing.
 3. Garbage Disposal Electrical Hook-up: See Section "Plumbing." Comply with NFPA 70 (NEC):
 - a. Wiring: Install from disposal through concealed spaces to house panel, anchoring wire, and providing necessary fittings.
 - b. Switch: Install above counter top backsplash.
 4. Range Hood Electrical Hook-up: See Section "Residential Appliances." Comply with NFPA 70 (NEC):
 - a. Electric service: Install insulated wire from range hood through concealed spaces to house panel, anchoring wire, and providing necessary fittings.
 5. Water Heater Electrical Hook-up: See Division 15 Section "Domestic Water Heaters." Comply with NFPA 70 (NEC).
 6. Furnace Electrical Hook-up: See Section "Furnaces." Comply with NFPA 70 (NEC).
 7. Smoke Detector Electrical Hook-up: See "Fire Alarm." Comply with NFPA 70 (NEC).
- F. Integrating Existing Work
1. Protection: Protect existing improvements from damage.
 - a. Where new work is to be connected to existing work, exercise special care not to disturb or damage existing work more than necessary.
 - b. Damaged Work: Replace, repair and restored to its original condition at no cost to the Owner.

END OF SECTION 26 05 19 16b

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SECTION 26 05 19 16c - CONDUCTORS AND CABLES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of conductors and cables. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Building wires and cables rated 600 V and less.
 - b. Connectors, splices, and terminations rated 600 V and less.
 - c. Sleeves and sleeve seals for cables.

C. Definitions

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

D. Submittals

1. Product Data: For each type of product indicated.
2. Field 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. Conductors And Cables

1. Aluminum and Copper, **as directed**, Conductors: Comply with NEMA WC 70.
2. Conductor Insulation: Comply with NEMA WC 70 for Types THW **OR** THHN-THWN **OR** XHHW **OR** UF **OR** USE **OR** SO, **as directed**.
3. Multiconductor Cable: Comply with NEMA WC 70 for armored cable, Type AC **OR** metal-clad cable, Type MC **OR** mineral-insulated, metal-sheathed cable, Type MI **OR** nonmetallic-sheathed cable, Type NM **OR** Type SO **OR** Type USE, **as directed**, with ground wire.

B. Connectors And Splices

1. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

C. Sleeves For Cables

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".

D. 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.

1.3 EXECUTION**A. Conductor Material Applications**

1. Feeders: Copper **OR** Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger, **as directed**. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Conductor Insulation And Multiconductor Cable Applications And Wiring Methods

1. Service Entrance: Type THHN-THWN, single conductors in raceway **OR** Type XHHW, single conductors in raceway **OR** Mineral-insulated, metal-sheathed cable, Type MI **OR** Type SE or USE multiconductor cable, **as directed**.
2. Exposed Feeders: Type THHN-THWN, single conductors in raceway **OR** Armored cable, Type AC **OR** Metal-clad cable, Type MC **OR** Mineral-insulated, metal-sheathed cable, Type MI **OR** Nonmetallic-sheathed cable, Type NM, **as directed**.
3. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway **OR** Armored cable, Type AC **OR** Metal-clad cable, Type MC **OR** Mineral-insulated, metal-sheathed cable, Type MI **OR** Nonmetallic-sheathed cable, Type NM, **as directed**.
4. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway **OR** Underground feeder cable, Type UF, **as directed**.
5. Feeders Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway **OR** Armored cable, Type AC **OR** Metal-clad cable, Type MC **OR** Mineral-insulated, metal-sheathed cable, Type MI, **as directed**.
6. Feeders in Cable Tray: Type THHN-THWN, single conductors in raceway **OR** Armored cable, Type AC **OR** Metal-clad cable, Type MC **OR** Mineral-insulated, metal-sheathed cable, Type MI **OR** Nonmetallic-sheathed cable, Type NM, **as directed**.
7. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway **OR** Armored cable, Type AC **OR** Metal-clad cable, Type MC **OR** Mineral-insulated, metal-sheathed cable, Type MI **OR** Nonmetallic-sheathed cable, Type NM, **as directed**.
8. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway **OR** Armored cable, Type AC **OR** Metal-clad cable, Type MC **OR** Mineral-insulated, metal-sheathed cable, Type MI **OR** Nonmetallic-sheathed cable, Type NM, **as directed**.
9. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway **OR** Underground branch-circuit cable, Type UF, **as directed**.
10. Branch Circuits Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway **OR** Armored cable, Type AC **OR** Metal-clad cable, Type MC **OR** Mineral-insulated, metal-sheathed cable, Type MI, **as directed**.

11. Branch Circuits in Cable Tray: Type THHN-THWN, single conductors in raceway **OR** Armored cable, Type AC **OR** Metal-clad cable, Type MC **OR** Mineral-insulated, metal-sheathed cable, Type MI, **as directed**.
 12. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
 13. Class 1 Control Circuits: Type THHN-THWN, in raceway.
 14. Class 2 Control Circuits: Type THHN-THWN, in raceway **OR** Power-limited cable, concealed in building finishes **OR** Power-limited tray cable, in cable tray, **as directed**.
- C. Installation Of Conductors And Cables
1. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
 2. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 3. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
 4. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
 5. Support cables according to Division 26 Section "Hangers And Supports For Electrical Systems".
 6. Identify and color-code conductors and cables according to Division 26 Section "Identification For Electrical Systems".
 7. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
 8. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - a. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
 9. Wiring at Outlets: Install conductor at each outlet, with at least **6 inches (150 mm) OR 12 inches (300 mm)**, **as directed**, of slack.
- D. 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 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 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 wall surfaces.
 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 cable unless sleeve seal is to be installed or unless seismic criteria require different clearance, **as directed**.
 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 cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants".

11. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping".
12. Roof-Penetration Sleeves: Seal penetration of individual cables 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. Size sleeves 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 cable and sleeve for installing mechanical sleeve seals.

E. Sleeve-Seal Installation

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

F. Firestopping

1. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping".

G. Field Quality Control

1. Perform tests and inspections and prepare test reports.
2. Tests and Inspections:
 - a. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services, **as directed**, for compliance with requirements.
 - b. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - c. Infrared Scanning: After Final Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
 - 1) Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Final Completion.
 - 2) Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 3) Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3. Test Reports: Prepare a written report to record the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
4. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 19 16c

SECTION 26 05 19 16d - UNDERCARPET CABLES

1.1 GENERAL

- A. Description Of Work
 - 1. This specification covers the furnishing and installation of undercarpet cables. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Undercarpet cable and service fittings for branch circuits.
 - b. Undercarpet cable and service fittings for communication and data transmission.
- C. Submittals
 - 1. Product Data: For each type of product indicated.
 - 2. Shop Drawings: Include plans, elevations, sections, details of components, and attachments to other work.
 - a. Indicate cable types, accessories, and transition boxes.
 - b. Indicate proposed layering of cables, cable dimensions, and installation requirements.
 - 3. Field quality-control test reports.
 - 4. Operation and maintenance data.
- D. 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 NEMA UC 2, "Undercarpet Power Distribution Systems" and with NFPA 70.

1.2 PRODUCTS

- A. Power Distribution Cable
 - 1. Cable: Factory laminated and complying with NEMA UC 2; three-piece assembly including bottom shield, conductor assembly, and top shield.
 - a. Bottom Shield: Abrasion resistant, nonmetallic **OR** Metallic, **as directed**.
 - b. Conductor Assembly: Two **OR** Three **OR** Four, **as directed**, -wire branch circuit with insulated ground, **as directed**.
 - c. Top Shield: Copper or copper alloy.
 - 2. Current Rating: 20 **OR** 30 **OR** 20 and 30, **as directed**, A.
- B. Communication And Data Cable
 - 1. Category 5e Communication and Data Cable: Extruded-vinyl jacket over 4 unshielded, twisted pairs, No. 24 AWG, copper; complying with TIA/EIA 568-B; and tested to **300-lb (136-kg)** rollover test.
- C. Pedestals
 - 1. Description: Manufacturer's standard low **OR** regular, **as directed**, -profile type, single **OR** two **OR** three, **as directed**, gang with single **OR** duplex, **as directed**, receptacles and Category 5e modular connectors, **as directed**.
 - a. Pedestal Colors: As selected from manufacturer's full range.
- D. Power Cable Transition Unit

1. Description: Interface transition unit, with junction box, for connecting three-, four-, or five-conductor, flat-conductor cable to building wiring system.

E. Communication And Data Cable Transition Unit

1. Description: Category 5 transition termination circuit board in wall-mounted box to convert round incoming cable to outgoing flat-undercarpet cable.

1.3 EXECUTION

A. Installation

1. Do not begin installation until heavy construction is completed and wheeled traffic is no longer a threat.
2. Do not stack cables in circulation routes.
3. Limit total installed height to 0.09 inch (2.29 mm).
4. Install cables in proper order with power-transmission cable first, followed by telephone cable and then data cable. Cross cables at 90-degree angles.
5. Install undercarpet cables and accessories using special tools as recommended by undercarpet cable manufacturer.

B. Connections

1. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
2. Connect undercarpet cable and components to branch circuits and to ground as indicated and instructed by manufacturer.

C. Field Quality Control

1. Perform tests and inspections and prepare test reports.
2. Tests and Inspections:
 - a. Branch-Circuit Cables: After cables have been installed and energized, perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - b. Communication and Data Cables: After cables have been installed and connected between telecommunications outlet and system cross-connect panel, test each cable according to TIA/EIA TSB67. Certify compliance with test parameters.
3. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 19 16d

SECTION 26 05 19 16e - MEDIUM-VOLTAGE CABLES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of medium-voltage cables. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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 cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

C. Definitions

1. NETA ATS: Acceptance Testing Specification.

D. Submittals

1. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.
2. Field 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 IEEE C2 and NFPA 70.

1.2 PRODUCTS

A. Cables

1. Cable Type: MV90 **OR** MV105, **as directed**.
2. Comply with UL 1072, AEIC CS 8, ICEA S-93-639, and ICEA S-97-682, **OR** ICEA S-94-649, **as directed**.
3. Conductor: Copper **OR** Aluminum, **as directed**.
4. Conductor Stranding: Compact round, concentric lay, Class B) **OR** Concentric lay, Class B, **as directed**.
5. Strand Filling: Conductor interstices are filled with impermeable compound.
6. Conductor Insulation: Crosslinked polyethylene **OR** Ethylene-propylene rubber, **as directed**.
 - a. Voltage Rating: 5 **OR** 8 **OR** 15 **OR** 25 **OR** 35, **as directed**, kV.
 - b. Insulation Thickness: 100 **OR** 133, **as directed**, percent insulation level.
7. Shielding: Copper tape **OR** Solid copper wires, **as directed**, helically applied over semiconducting insulation shield.
8. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.
9. Three-Conductor Cable Assembly: Three insulated, shielded conductors cabled together with ground conductors, **as directed**.
 - a. Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding.
10. Cable Armor: Interlocked aluminum **OR** Interlocked galvanized steel **OR** Corrugated aluminum tube, **as directed**, applied over cable.
11. Cable Jacket: Sunlight-resistant PVC **OR** Chlorosulfonated polyethylene, CPE, **as directed**.

B. Splice Kits

1. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.
2. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
 - a. Combination tape and cold-shrink-rubber sleeve kit with re-jacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
 - b. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
 - c. Premolded, cold-shrink-rubber, in-line splicing kit.
 - d. Premolded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

C. Solid Terminations

1. Multiconductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.
 - a. Compound-filled, cast-metal body, metal-clad cable terminator for metal-clad cable with **OR** without, **as directed**, external plastic jacket.
 - b. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.
 - c. Heat-shrink sheath seal kit with phase- and ground-conductor re-jacketing tubes, cable-end sealing boot, and sealing plugs for unused ground-wire openings in boot.
 - d. Cast-epoxy-resin sheath seal kit with wraparound mold and packaged, two-part, epoxy-resin casting material.
2. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.
 - a. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
 - b. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
 - c. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
 - d. Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.
 - e. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
 - f. Class 3 Terminations: Kit with stress cone and compression-type connector.
3. Nonshielded-Cable Terminations: Kit with compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.

D. Separable Insulated Connectors

1. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.
2. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.
3. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

4. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
 5. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
 - a. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
 - b. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
 - c. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
 - d. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.
 6. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.
 7. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.
- E. Arc-Proofing Materials
1. Tape for First Course on Metal Objects: **10-mil- (250-micrometer-)** thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.
 2. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to **0.3 inch (8 mm)** thick, compatible with cable jacket.
 3. Glass-Cloth Tape: Pressure-sensitive adhesive type, **1/2 inch (13 mm)** wide.
- F. Fault Indicators
1. Indicators: Automatically **OR** Manually, **as directed**, reset fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.
 2. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.
- G. Source Quality Control
1. Test and inspect cables according to ICEA S-97-682 **OR** ICEA S-94-649, **as directed**, before shipping.
 2. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of **5 psig (35 kPa)**.

1.3 EXECUTION

- A. Installation
1. Install cables according to IEEE 576.
 2. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 - a. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
 - b. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

3. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
4. Support cables according to Division 26 Section "Common Work Results For Electrical".
5. Install direct-buried cables on leveled and tamped bed of **3-inch- (75-mm-)** thick, clean sand. Separate cables crossing other cables or piping by a minimum of **4 inches (100 mm)** of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices.
6. Install "buried-cable" warning tape **12 inches (305 mm)** above cables.
7. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.
8. Install cable splices at pull points and elsewhere as indicated; use standard kits.
9. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits.
10. Install separable insulated-connector components as follows:
 - a. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
 - b. Portable Feed-Through Accessory: Three.
 - c. Standoff Insulator: Three.
11. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
 - a. Clean cable sheath.
 - b. Wrap metallic cable components with **10-mil (250-micrometer)** pipe-wrapping tape.
 - c. Smooth surface contours with electrical insulation putty.
 - d. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
 - e. Band arc-proofing tape with **1-inch- (25-mm-)** wide bands of half-lapped, adhesive, glass-cloth tape **2 inches (50 mm)** o.c.
12. Seal around cables passing through fire-rated elements according to Division 07 Section "Penetration Firestopping".
13. Install fault indicators on each phase where indicated.
14. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
15. Identify cables according to Division 26 Section "Identification For Electrical Systems".

B. Field Quality Control

1. Perform the following field tests and inspections and prepare test reports:
 - a. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - b. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
2. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 19 16e

SECTION 26 05 19 16f - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for communications equipment room fittings. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Telecommunications mounting elements.
 - b. Backboards.
 - c. Telecommunications equipment racks and cabinets.
 - d. Telecommunications service entrance pathways.
 - e. Grounding.

C. Definitions

1. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
2. BICSI: Building Industry Consulting Service International.
3. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel not exceeding 6 inches (152 mm) in width.
4. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
5. LAN: Local area network.
6. RCDD: Registered Communications Distribution Designer.
7. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of a bottom without ventilation openings within integral or separate longitudinal side rails.
8. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.

D. Performance Requirements

1. Seismic Performance: Floor-mounted cabinets and cable pathways 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 and the unit will be fully operational after the seismic event."

E. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: For communications equipment room fittings. 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. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
 - c. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.
3. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
4. Seismic Qualification Certificates: For floor-mounted cabinets, 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. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
- c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Quality Assurance

1. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff **OR** personnel must possess the standards and experience for membership.
 - a. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD **OR** RCDD/NTS **OR** possess the standards and experience for membership **OR** Commercial Installer, Level 2, **as directed**.
 - b. Installation Supervision: Installation shall be under the direct supervision of Registered Technician **OR** Level 2 Installer, **as directed**, who shall be present at all times when Work of this Section is performed at Project site.
 - c. Field Inspector: Currently registered by BICSI as RCDD **OR** possess the standards and experience for membership **OR** Commercial Installer, Level 2, **as directed**, to perform the on-site inspection.
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. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
4. Grounding: Comply with ANSI-J-STD-607-A.

G. Project Conditions

1. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.

H. Coordination

1. Coordinate layout and installation of communications equipment with the Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
 - a. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and the Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
 - b. Record agreements reached in meetings and distribute them to other participants.
 - c. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
 - d. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
2. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

1.2 PRODUCTS

A. Pathways

1. General Requirements: Comply with TIA/EIA-569-A.

2. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.
 - a. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
 - b. Support brackets with cable tie slots for fastening cable ties to brackets.
 - c. Lacing bars, spools, J-hooks, and D-rings.
 - d. Straps and other devices.
 3. Cable Trays:
 - a. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than **0.000472 inch (0.012 mm)** thick **OR** hot-dip galvanizing, complying with ASTM A 123/A 123M, Grade 0.55, not less than **0.002165 inch (0.055 mm)** thick, **as directed**.
 - 1) Basket Cable Trays: **6 inches (150 mm)** wide and **2 inches (50 mm)** deep. Wire mesh spacing shall not exceed **2 by 4 inches (50 by 100 mm)**.
 - 2) Trough Cable Trays: Nominally **6 inches (150 mm)** wide.
 - 3) Ladder Cable Trays: Nominally **18 inches (455 mm)** wide, and a rung spacing of **12 inches (305 mm)**.
 - 4) Channel Cable Trays: One-piece construction, nominally **4 inches (100 mm)** wide. Slot spacing shall not exceed **4-1/2 inches (115 mm)** o.c.
 - 5) Solid-Bottom Cable Trays: One-piece construction, nominally **12 inches (305 mm)** wide. Provide with **OR** without, **as directed**, solid covers.
 4. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems". Flexible metal conduit shall not be used.
 - a. Outlet boxes shall be no smaller than **2 inches (50 mm)** wide, **3 inches (75 mm)** high, and **2-1/2 inches (64 mm)** deep.
- B. Backboards
1. Backboards: Plywood, fire-retardant treated, **as directed**, **3/4 by 48 by 96 inches (19 by 1220 by 2440 mm)**. Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry".
- C. Equipment Frames
1. General Frame Requirements:
 - a. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - b. Module Dimension: Width compatible with EIA 310 standard, **19-inch (480-mm)** panel mounting.
 - c. Finish: Manufacturer's standard, baked-polyester powder coat.
 2. Floor-Mounted Racks: Modular-type, steel **OR** aluminum, **as directed**, construction.
 - a. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip, **as directed**.
 - b. Baked-polyester powder coat finish.
 3. Modular Freestanding Cabinets:
 - a. Removable and lockable side panels.
 - b. Hinged and lockable front and rear doors.
 - c. Adjustable feet for leveling.
 - d. Screened ventilation openings in the roof and rear door.
 - e. Cable access provisions in the roof and base.
 - f. Grounding bus bar.
 - g. Rack **OR** Roof, **as directed**, -mounted, **550-cfm (260-L/s)** fan with filter.
 - h. Power strip.
 - i. Baked-polyester powder coat finish.
 - j. All cabinets keyed alike.

4. Modular Wall Cabinets:
 - a. Wall mounting.
 - b. Steel **OR** Aluminum, **as directed**, construction.
 - c. Treated to resist corrosion.
 - d. Lockable front and rear doors.
 - e. Louvered side panels.
 - f. Cable access provisions top and bottom.
 - g. Grounding lug.
 - h. Rack **OR** Roof, **as directed**, -mounted, 250-cfm (118-L/s) fan.
 - i. Power strip.
 - j. All cabinets keyed alike.
5. Cable Management for Equipment Frames:
 - a. Metal, with integral wire retaining fingers.
 - b. Baked-polyester powder coat finish.
 - c. Vertical cable management panels shall have front and rear channels, with covers.
 - d. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

D. Power Strips

1. Power Strips: Comply with UL 1363.
 - a. Rack mounting.
 - b. Six, 15-A, 120-V ac, NEMA WD 6, Configuration 5-15R **OR** 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R, **as directed**, receptacles.
 - c. LED indicator lights for power and protection status.
 - d. LED indicator lights for reverse polarity and open outlet ground.
 - e. Circuit Breaker and Thermal Fusing:
 - 1) When protection is lost, circuit opens and cannot be reset.

OR

 Unit continues to supply power if protection is lost.
 - f. Close-coupled, direct plug-in **OR** Cord connected with 15-foot (4.5-m), **as directed**, line cord.
 - g. Rocker-type on-off switch, illuminated when in on position.
 - h. Peak Single-Impulse Surge Current Rating: 33 **OR** 26 **OR** 13, **as directed**, kA per phase.
 - i. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all 3 modes shall be not more than 330 V.

E. Grounding

1. Comply with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems" for grounding conductors and connectors.
2. Telecommunications Main Bus Bar:
 - a. Connectors: Mechanical type, cast silicon bronze, solderless compression **OR** exothermic, **as directed**, -type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
 - b. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide (6 mm thick by 100 mm wide) with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart.
 - c. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.
3. Comply with ANSI-J-STD-607-A.

F. Labeling

1. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

1.3 EXECUTION

- A. Entrance Facilities
 - 1. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.
 - 2. Install underground **OR** buried **OR** aerial, **as directed**, pathways complying with recommendations in TIA/EIA-569-A, "Entrance Facilities" Article.
 - a. Install underground **OR** buried, **as directed**, entrance pathway complying with Division 26 Section "Raceway And Boxes For Electrical Systems".
- B. Installation
 - 1. Comply with NECA 1.
 - 2. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
 - 3. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.
 - 4. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- C. Firestopping
 - 1. Comply with requirements in Division 07 Section "Penetration Firestopping".
 - 2. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
 - 3. Comply with BICSI TDMM, "Firestopping Systems" Article.
- D. Grounding
 - 1. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
 - 2. Comply with ANSI-J-STD-607-A.
 - 3. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least **2-inch (50-mm)** clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
 - 4. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
 - a. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.
- E. Identification
 - 1. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Division 26 Section "Identification For Electrical Systems".
 - 2. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
 - 3. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 **OR** Class 3 **OR** Class 4, **as directed**, level of administration including optional identification requirements of this standard, **as directed**.
 - 4. Labels shall be preprinted or computer-printed type.

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SECTION 26 05 19 16g - COMMUNICATIONS BACKBONE CABLING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for communications backbone cabling. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Pathways.
 - b. UTP cable.
 - c. 50/125 and 62.5/125-micrometer, optical fiber cabling.
 - d. Coaxial cable.
 - e. Cable connecting hardware, patch panels, and cross-connects.
 - f. Cabling identification products.

C. Definitions

1. BICSI: Building Industry Consulting Service International.
2. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
3. EMI: Electromagnetic interference.
4. IDC: Insulation displacement connector.
5. LAN: Local area network.
6. RCDD: Registered Communications Distribution Designer.
7. UTP: Unshielded twisted pair.

D. Backbone Cabling Description

1. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
2. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

E. Performance Requirements

1. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

F. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings:
 - a. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by the Owner.
 - b. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - c. Cabling administration drawings and printouts.
 - d. Wiring diagrams to show typical wiring schematics including the following:
 - 1) Cross-connects.
 - 2) Patch panels.
 - 3) Patch cords.

- e. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
 - f. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements.
 3. Qualification Data: For Installer, **as directed**, qualified layout technician, installation supervisor, and field inspector.
 4. Source quality-control reports.
 5. Field quality-control reports.
 6. Maintenance Data.
 7. Software and Firmware Operational Documentation:
 - a. Software operating and upgrade manuals.
 - b. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - c. Device address list.
 - d. Printout of software application and graphic screens.
- G. Quality Assurance
1. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff **OR** personnel must possess the standards and experience for membership, **as directed**.
 - a. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD **OR** personnel that possess the standards and experience for membership, **as directed**.
 - b. Installation Supervision: Installation shall be under the direct supervision of Registered Technician **OR** Level 2 Installer, **as directed**, who shall be present at all times when Work of this Section is performed at Project site.
 2. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.
 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 4. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
 5. Grounding: Comply with ANSI-J-STD-607-A.
- H. Delivery, Storage, And Handling
1. Test cables upon receipt at Project site.
 - a. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
 - b. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
 - c. Test each pair of UTP cable for open and short circuits.
- I. Software Service Agreement
1. Technical Support: Beginning with Final Completion, provide software support for two years.
 2. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Final Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - a. Provide 30 days' notice to the Owner to allow scheduling and access to system and to allow the Owner to upgrade computer equipment if necessary.

1.2 PRODUCTS

A. Pathways

1. General Requirements: Comply with TIA/EIA-569-A.
2. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
 - a. Support brackets with cable tie slots for fastening cable ties to brackets.
 - b. Lacing bars, spools, J-hooks, and D-rings.
 - c. Straps and other devices.
3. Cable Trays:
 - a. Cable Tray Material: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than **0.000472 inches (0.012 mm)** thick **OR** hot-dip galvanizing, complying with ASTM A 123/A 123M, Grade 0.55, not less than **0.002165 inches (0.055 mm)** thick, **as directed**.
 - 1) Basket Cable Trays: **6 inches (150 mm)** wide and **2 inches (50 mm)** deep. Wire mesh spacing shall not exceed **2 by 4 inches (50 by 100 mm)**.
 - 2) Trough Cable Trays: Nominally **6 inches (150 mm)** wide.
 - 3) Ladder Cable Trays: Nominally **18 inches (455 mm)** wide, and a rung spacing of **12 inches (305 mm)**.
 - 4) Channel Cable Trays: One-piece construction, nominally **4 inches (100 mm)** wide. Slot spacing shall not exceed **4-1/2 inches (115 mm)** o.c.
 - 5) Solid-Bottom Cable Trays: One-piece construction, nominally **12 inches (305 mm)** wide. Provide with **OR** without, **as directed**, solid covers.
4. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems". Flexible metal conduit shall not be used.
 - a. Outlet boxes shall be no smaller than **2 inches (50 mm)** wide, **3 inches (75 mm)** high, and **2-1/2 inches (64 mm)** deep.

B. Backboards

1. Backboards: Plywood, fire-retardant treated, **as directed**, **3/4 by 48 by 96 inches (19 by 1220 by 2440 mm)**. Comply with requirements in Division 06 Section "Rough Carpentry" for plywood backing panels.

C. UTP Cable

1. Description: 100-ohm, 100-pair UTP, formed into 25-pair binder groups covered with a gray thermoplastic jacket and overall metallic shield.
 - a. Comply with ICEA S-90-661 for mechanical properties.
 - b. Comply with TIA/EIA-568-B.1 for performance specifications.
 - c. Comply with TIA/EIA-568-B.2, Category 5e **OR** Category 6, **OR** Category 6e **as directed**.
 - d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - 1) Communications, General Purpose: Type CM or CMG; or MPP, CMP, MPR, CMR, MP, or MPG, **as directed**.
 - 2) Communications, Plenum Rated: Type CMP or MPP, **as directed**, complying with NFPA 262.
 - 3) Communications, Riser Rated: Type CMR; or MPP, CMP, or MPR, **as directed**, complying with UL 1666.
 - 4) Communications, Limited Purpose: Type CMX; or MPP, CMP, MPR, CMR, MP, MPG, CM, or CMG, **as directed**.
 - 5) Multipurpose: Type MP or MPG; or MPP or MPR, **as directed**.
 - 6) Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
 - 7) Multipurpose, Riser Rated: Type MPR or MPP, **as directed**, complying with UL 1666.

D. UTP Cable Hardware

1. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
2. Connecting Blocks: 110-style IDC for Category 5e **OR** 110-style IDC for Category 6 **OR** 66-style IDC for Category 5e, **OR** 110-style IDC for Category 6e **as directed**. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
3. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
 - a. Number of Terminals per Field: One for each conductor in assigned cables.
4. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
 - a. Number of Jacks per Field: One for each four-pair UTP cable indicated **OR** conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria, **as directed**.
5. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
6. Patch Cords: Factory-made, 4-pair cables in **36-inch (900-mm)** **OR** **48-inch (1200-mm)**, **as directed**, lengths; terminated with 8-position modular plug at each end.
 - a. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
 - b. Patch cords shall have color-coded boots for circuit identification.

E. Optical Fiber Cable

1. Description: Multimode, 50/125 **OR** 62.5/125, **as directed**, -micrometer, 24-fiber, nonconductive, **as directed**, tight buffer, optical fiber cable.
 - a. Comply with ICEA S-83-596 for mechanical properties.
 - b. Comply with TIA/EIA-568-B.3 for performance specifications.
 - c. Comply with TIA/EIA-492AAAA-B **OR** TIA/EIA-492AAAA-A, **as directed**, for detailed specifications.
 - d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - 1) General Purpose, Nonconductive: Type OFN or OFNG, or OFNR, OFNP, **as directed**.
 - 2) Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
 - 3) Riser Rated, Nonconductive: Type OFNR or OFNP, **as directed**, complying with UL 1666.
 - 4) General Purpose, Conductive: Type OFC or OFCG; or OFNG, OFN, OFCR, OFNR, OFCP, or OFNP, **as directed**.
 - 5) Plenum Rated, Conductive: Type OFCP or OFNP, **as directed**, complying with NFPA 262.
 - 6) Riser Rated, Conductive: Type OFCR; or OFNR, OFCP, or OFNP, **as directed**, complying with UL 1666.
 - e. Conductive cable shall be steel **OR** aluminum, **as directed**, armored type.
 - f. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
 - g. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
2. Jacket:
 - a. Jacket Color: Aqua for 50/125-micrometer cable **OR** Orange for 62.5/125-micrometer cable, **as directed**.
 - b. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
 - c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inches (1000 mm)**.

F. Optical Fiber Cable Hardware

1. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
 - a. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
 2. Patch Cords: Factory-made, dual-fiber cables in **36-inch (900-mm)** lengths.
 3. Cable Connecting Hardware:
 - a. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
 - b. Quick-connect, simplex and duplex, Type SC **OR** Type ST **OR** Type LC **OR** Type MT-RJ, **as directed**, connectors. Insertion loss not more than 0.75 dB.
 - c. Type SFF connectors may be used in termination racks, panels, and equipment packages.
- G. Coaxial Cable
1. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.
 2. RG-11/U: NFPA 70, Type CATV.
 - a. No. 14 AWG, solid, copper-covered steel conductor.
 - b. Gas-injected, foam-PE insulation.
 - c. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
 - d. Jacketed with sunlight-resistant, black PVC or PE.
 - e. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg C.
 3. RG59/U: NFPA 70, Type CATVR.
 - a. No. 20 AWG, solid, silver-plated, copper-covered steel conductor.
 - b. Gas-injected, foam-PE insulation.
 - c. Triple shielded with 100 percent aluminum polyester tape and 95 percent aluminum braid; covered by aluminum foil with grounding strip.
 - d. Color-coded PVC jacket.
 4. RG-6/U: NFPA 70, Type CATV or CM.
 - a. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
 - b. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
 - c. Jacketed with black PVC or PE.
 - d. Suitable for indoor installations.
 5. RG59/U: NFPA 70, Type CATV.
 - a. No. 20 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
 - b. Double shielded with 100 percent aluminum polyester tape and 40 percent aluminum braid.
 - c. PVC jacket.
 6. RG59/U (Plenum Rated): NFPA 70, Type CMP.
 - a. No. 20 AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
 - b. Double shielded with 100 percent aluminum-foil shield and 65 percent aluminum braid.
 - c. Copolymer jacket.
 7. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:
 - a. CATV Cable: Type CATV, or CATVP or CATVR, **as directed**.
 - b. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
 - c. CATV Riser Rated: Type CATVR; or CATVP, CATVR, or CATV, **as directed**, complying with UL 1666.
 - d. CATV Limited Rating: Type CATVX.
- H. Coaxial Cable Hardware
1. Coaxial-Cable Connectors: Type BNC, 75 ohms.
- I. Grounding

1. Comply with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems" for grounding conductors and connectors.
2. Comply with ANSI-J-STD-607-A.

J. Identification Products

1. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

K. Source Quality Control

1. Testing Agency: Engage a qualified testing agency to evaluate cables.
2. Factory test cables on reels according to TIA/EIA-568-B.1.
3. Factory test UTP cables according to TIA/EIA-568-B.2.
4. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.
5. Cable will be considered defective if it does not pass tests and inspections.
6. Prepare test and inspection reports.

1.3 EXECUTION

A. Entrance Facilities

1. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

B. Wiring Methods

1. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
 - a. Install plenum cable in environmental air spaces, including plenum ceilings.
 - b. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
2. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
3. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

C. Installation Of Pathways

1. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A.
2. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings". Drawings indicate general arrangement of pathways and fittings.
3. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
4. Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems" for installation of conduits and wireways.
5. Install manufactured conduit sweeps and long-radius elbows whenever possible.
6. Pathway Installation in Communications Equipment Rooms:
 - a. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
 - b. Install cable trays to route cables if conduits cannot be located in these positions.
 - c. Secure conduits to backboard when entering room from overhead.
 - d. Extend conduits **3 inches (76 mm)** above finished floor.

- e. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- 7. Backboards: Install backboards with **96-inch (2440-mm)** dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

D. Installation Of Cables

- 1. Comply with NECA 1.
- 2. General Requirements for Cabling:
 - a. Comply with TIA/EIA-568-B.1.
 - b. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 - c. Install 110-style IDC termination hardware unless otherwise indicated.
 - d. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - e. Cables may not be spliced. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - f. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - g. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
 - h. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - i. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 - j. In the communications equipment room, install a **10-foot- (3-m-)** long service loop on each end of cable.
 - k. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- 3. UTP Cable Installation:
 - a. Comply with TIA/EIA-568-B.2.
 - b. Do not untwist UTP cables more than **1/2 inch (12 mm)** from the point of termination to maintain cable geometry.
- 4. Optical Fiber Cable Installation:
 - a. Comply with TIA/EIA-568-B.3.
 - b. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
- 5. Open-Cable Installation:
 - a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 - b. Suspend UTP cable not in a wireway or pathway, a minimum of **8 inches (200 mm)** above ceilings by cable supports not more than **60 inches (1524 mm)** apart.
 - c. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- 6. Installation of Cable Routed Exposed under Raised Floors:
 - a. Install plenum-rated cable only.
 - b. Install cabling after the flooring system has been installed in raised floor areas.
 - c. Coil cable **6 feet (1800 mm)** long not less than **12 inches (300 mm)** in diameter below each feed point.
- 7. Outdoor Coaxial Cable Installation:
 - a. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
 - b. Attach antenna lead-in cable to support structure at intervals not exceeding **36 inches (915 mm)**.
- 8. Group connecting hardware for cables into separate logical fields.
- 9. Separation from EMI Sources:

- a. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 - b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of **5 inches (127 mm)**.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of **12 inches (300 mm)**.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of **24 inches (610 mm)**.
 - c. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of **2-1/2 inches (64 mm)**.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of **6 inches (150 mm)**.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of **12 inches (300 mm)**.
 - d. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of **3 inches (76 mm)**.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of **6 inches (150 mm)**.
 - e. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of **48 inches (1200 mm)**.
 - f. Separation between Communications Cables and Fluorescent Fixtures: A minimum of **5 inches (127 mm)**.
- E. Firestopping
1. Comply with requirements in Division 07 Section "Penetration Firestopping".
 2. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
 3. Comply with BICSI TDMM, "Firestopping Systems" Article.
- F. Grounding
1. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
 2. Comply with ANSI-J-STD-607-A.
 3. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least **2-inch (50-mm)** clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
 4. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
- G. Identification
1. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".
 - a. Administration Class: **1 OR 2 OR 3 OR 4, as directed**.
 - b. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
 2. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
 3. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class **2 OR Class 3 OR Class 4, as directed**, level of administration including optional identification requirements of this standard.

4. Comply with requirements in Division 27 Section "Communications Horizontal Cabling" for cable and asset management software.
5. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
6. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
7. Cable and Wire Identification:
 - a. Label each cable within **4 inches (100 mm)** of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - b. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 - c. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding **15 feet (4.5 m)**.
 - d. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - 1) Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
 - 2) Label each unit and field within distribution racks and frames.
 - e. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
8. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:
 - a. Cables use flexible vinyl or polyester that flexes as cables are bent.

H. Field Quality Control

1. Tests and Inspections:
 - a. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
 - b. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - c. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - 1) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - d. Optical Fiber Cable Tests:
 - 1) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - 2) Link End-to-End Attenuation Tests:

- a) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
 - b) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.
2. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
3. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
4. End-to-end cabling will be considered defective if it does not pass tests and inspections.
5. Prepare test and inspection reports.

END OF SECTION 26 05 19 16g

SECTION 26 05 19 16h - COMMUNICATIONS HORIZONTAL CABLING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for communications horizontal cabling. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Pathways.
 - b. UTP cabling.
 - c. 50/125 and 62.5/125-micrometer, optical fiber cabling.
 - d. Coaxial cable.
 - e. Multiuser telecommunications outlet assemblies.
 - f. Cable connecting hardware, patch panels, and cross-connects.
 - g. Telecommunications outlet/connectors.
 - h. Cabling system identification products.
 - i. Cable management system.

C. Definitions

1. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
2. BICSI: Building Industry Consulting Service International.
3. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel.
4. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
5. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
6. EMI: Electromagnetic interference.
7. IDC: Insulation displacement connector.
8. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
9. LAN: Local area network.
10. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.
11. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
12. RCDD: Registered Communications Distribution Designer.
13. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom without ventilation openings.
14. Trough or Ventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom having openings for the passage of air.
15. UTP: Unshielded twisted pair.

D. Horizontal Cabling Description

1. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
 - a. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.

- b. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
- c. Bridged taps and splices shall not be installed in the horizontal cabling.
- d. Splitters shall not be installed as part of the optical fiber cabling.
- 2. A work area is approximately **100 sq. ft. (9.3 sq. m)**, and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
- 3. The maximum allowable horizontal cable length is **295 feet (90 m)**. This maximum allowable length does not include an allowance for the length of **16 feet (4.9 m)** to the workstation equipment. The maximum allowable length does not include an allowance for the length of **16 feet (4.9 m)** in the horizontal cross-connect.

E. Performance Requirements

- 1. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

F. Submittals

- 1. Product Data: For each type of product indicated.
- 2. Shop Drawings:
 - a. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by the Owner.
 - b. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - c. Cabling administration drawings and printouts.
 - d. Wiring diagrams to show typical wiring schematics, including the following:
 - 1) Cross-connects.
 - 2) Patch panels.
 - 3) Patch cords.
 - e. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
 - f. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements.
- 3. Samples: For workstation outlets, jacks, jack assemblies, in specified finish, one for each size and outlet configuration and faceplates for color selection and evaluation of technical features.
- 4. Qualification Data: For Installer, **as directed**, qualified layout technician, installation supervisor, and field inspector.
- 5. Source quality-control reports.
- 6. Field quality-control reports.
- 7. Maintenance Data.
- 8. Software and Firmware Operational Documentation:
 - a. Software operating and upgrade manuals.
 - b. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - c. Device address list.
 - d. Printout of software application and graphic screens.

G. Quality Assurance

- 1. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff **OR** personnel must possess the standards and experience for membership, **as directed**.
 - a. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD **OR** personnel that possess the standards and experience for membership, **as directed**.
 - b. Installation Supervision: Installation shall be under the direct supervision of Registered Technician **OR** Level 2 Installer, **as directed**, who shall be present at all times when Work of this Section is performed at Project site.

2. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 50 **OR** 450, **as directions**, or less.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
5. Grounding: Comply with ANSI-J-STD-607-A.

H. Delivery, Storage, And Handling

1. Test cables upon receipt at Project site.
 - a. Test optical fiber cables to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
 - b. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.
 - c. Test each pair of UTP cable for open and short circuits.

I. Software Service Agreement

1. Technical Support: Beginning with Final Completion, provide software support for two years.
2. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Final Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - a. Provide 30 days' notice to the Owner to allow scheduling and access to system and to allow the Owner to upgrade computer equipment if necessary.

1.2 PRODUCTS

A. Pathways

1. General Requirements: Comply with TIA/EIA-569-A.
2. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
 - a. Support brackets with cable tie slots for fastening cable ties to brackets.
 - b. Lacing bars, spools, J-hooks, and D-rings.
 - c. Straps and other devices.
3. Cable Trays:
 - a. Cable Tray Materials: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than **0.000472 inch (0.012 mm)** thick **OR** hot-dip galvanizing, complying with ASTM A 123/A 123M, Grade 0.55, not less than **0.002165 inch (0.055 mm)** thick, **as directed**.
 - 1) Basket Cable Trays: **6 inches (150 mm)** wide and **2 inches (50 mm)** deep. Wire mesh spacing shall not exceed **2 by 4 inches (50 by 100 mm)**.
 - 2) Trough Cable Trays: Nominally **6 inches (150 mm)** wide.
 - 3) Ladder Cable Trays: Nominally **18 inches (455 mm)** wide, and a rung spacing of **12 inches (305 mm)**.
 - 4) Channel Cable Trays: One-piece construction, nominally **4 inches (100 mm)** wide. Slot spacing shall not exceed **4-1/2 inches (115 mm)** o.c.
 - 5) Solid-Bottom Cable Trays: One-piece construction, nominally **12 inches (305 mm)** wide. Provide with **OR** without, **as directed**, solid covers.
4. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems". Flexible metal conduit shall not be used.

- a. Outlet boxes shall be no smaller than **2 inches (50 mm)** wide, **3 inches (75 mm)** high, and **2-1/2 inches (64 mm)** deep.
- B. Backboards
1. Backboards: Plywood, fire-retardant treated, **as directed**, **3/4 by 48 by 96 inches (19 by 1220 by 2440 mm)**. Comply with requirements in Division 06 Section "Rough Carpentry" for plywood backing panels.
- C. UTP Cable
1. Description: 100-ohm, 4-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.
 - a. Comply with ICEA S-90-661 for mechanical properties.
 - b. Comply with TIA/EIA-568-B.1 for performance specifications.
 - c. Comply with TIA/EIA-568-B.2, Category 5e **OR** Category 6, **OR** Category 6e **as directed**.
 - d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - 1) Communications, General Purpose: Type CM or CMG; or MPP, CMP, MPR, CMR, MP, or MPG, **as directed**.
 - 2) Communications, Plenum Rated: Type CMP or MPP, **as directed**, complying with NFPA 262.
 - 3) Communications, Riser Rated: Type CMR; or MPP, CMP, or MPR, **as directed**, complying with UL 1666.
 - 4) Communications, Limited Purpose: Type CMX; or MPP, CMP, MPR, CMR, MP, MPG, CM, or CMG, **as directed**.
 - 5) Multipurpose: Type MP or MPG; or MPP or MPR, **as directed**.
 - 6) Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
 - 7) Multipurpose, Riser Rated: Type MPR or MPP, **as directed**, complying with UL 1666.
- D. UTP Cable Hardware
1. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
 2. Connecting Blocks: 110-style IDC for Category 5e **OR** 110-style IDC for Category 6 **OR** 66-style IDC for Category 5e, **OR** 110-style IDC for Category 6e **as directed**. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
 3. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
 - a. Number of Terminals per Field: One for each conductor in assigned cables.
 4. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
 - a. Number of Jacks per Field: One for each four-pair UTP cable indicated **OR** conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria, **as directed**.
 5. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
 6. Patch Cords: Factory-made, four-pair cables in **36-inch (900 mm) OR 48-inch (1200-mm), as directed**, lengths; terminated with eight-position modular plug at each end.
 - a. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
 - b. Patch cords shall have color-coded boots for circuit identification.
- E. Optical Fiber Cable

1. Description: Multimode, 50/125 **OR** 62.5/125, **as directed**, -micrometer, 24-fiber, nonconductive, **as directed**, tight buffer, optical fiber cable.
 - a. Comply with ICEA S-83-596 for mechanical properties.
 - b. Comply with TIA/EIA-568-B.3 for performance specifications.
 - c. Comply with TIA/EIA-492AAAA-B **OR** TIA/EIA-492AAAA-A, **as directed**, for detailed specifications.
 - d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - 1) General Purpose, Nonconductive: Type OFN or OFNG, or OFNR, OFNP, **as directed**.
 - 2) Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
 - 3) Riser Rated, Nonconductive: Type OFNR or OFNP, **as directed**, complying with UL 1666.
 - 4) General Purpose, Conductive: Type OFC or OFCG; or OFNG, OFN, OFCR, OFNR, OFCP, or OFNP, **as directed**.
 - 5) Plenum Rated, Conductive: Type OFCP or OFNP, **as directed**, complying with NFPA 262.
 - 6) Riser Rated, Conductive: Type OFCR; or OFNR, OFCP, or OFNP, **as directed**, complying with UL 1666.
 - e. Conductive cable shall be steel **OR** aluminum, **as directed**, armored type.
 - f. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
 - g. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
2. Jacket:
 - a. Jacket Color: Aqua for 50/125-micrometer cable **OR** Orange for 62.5/125-micrometer cable, **as directed**.
 - b. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
 - c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inches (1000 mm)**.

F. Optical Fiber Cable Hardware

1. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
 - a. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
2. Patch Cords: Factory-made, dual-fiber cables in **36-inch (900-mm)** lengths.
3. Cable Connecting Hardware:
 - a. Comply with Optical Fiber Connector Interchangeability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
 - b. Quick-connect, simplex and duplex, Type SC **OR** Type ST **OR** Type LC **OR** Type MT-RJ, **as directed**, connectors. Insertion loss not more than 0.75 dB.
 - c. Type SFF connectors may be used in termination racks, panels, and equipment packages.

G. Coaxial Cable

1. Cable Characteristics: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.
2. RG-11/U: NFPA 70, Type CATV.
 - a. No. 14 AWG, solid, copper-covered steel conductor.
 - b. Gas-injected, foam-PE insulation.
 - c. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
 - d. Jacketed with sunlight-resistant, black PVC or PE.
 - e. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg C.
3. RG59/U: NFPA 70, Type CATVR.
 - a. No. 20 AWG, solid, silver-plated, copper-covered steel conductor.
 - b. Gas-injected, foam-PE insulation.

- c. Triple shielded with 100 percent aluminum polyester tape and 95 percent aluminum braid; covered by aluminum foil with grounding strip.
 - d. Color-coded PVC jacket.
- 4. RG-6/U: NFPA 70, Type CATV or CM.
 - a. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
 - b. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
 - c. Jacketed with black PVC or PE.
 - d. Suitable for indoor installations.
- 5. RG59/U: NFPA 70, Type CATV.
 - a. No. 20 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
 - b. Double shielded with 100 percent aluminum polyester tape and 40 percent aluminum braid.
 - c. PVC jacket.
- 6. RG59/U (Plenum Rated): NFPA 70, Type CMP.
 - a. No. 20 AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
 - b. Double shielded with 100 percent aluminum-foil shield and 65 percent aluminum braid.
 - c. Copolymer jacket.
- 7. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:
 - a. CATV Cable: Type CATV or CATVP or CATVR, **as directed**.
 - b. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
 - c. CATV Riser Rated: Type CATVR; or CATVP, CATVR, or CATV, **as directed**, complying with UL 1666.
 - d. CATV Limited Rating: Type CATVX.

H. Coaxial Cable Hardware

- 1. Coaxial-Cable Connectors: Type BNC, 75 ohms.

I. Consolidation Points

- 1. Description: Consolidation points shall comply with requirements for cable connecting hardware.
 - a. Number of Terminals per Field: One for each conductor in assigned cables.
 - b. Number of Connectors per Field:
 - 1) One for each four-pair UTP cable indicated.
 - 2) One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.
 - c. Mounting: Recessed in ceiling **OR** Wall **OR** Desk **OR** Furniture, **as directed**.
 - d. NRTL listed as complying with UL 50 and UL 1863.
 - e. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

J. Multiuser Telecommunications Outlet Assembly (MUTOA)

- 1. Description: MUTOAs shall meet the requirements for cable connecting hardware.
 - a. Number of Terminals per Field: One for each conductor in assigned cables.
 - b. Number of Connectors per Field:
 - 1) One for each four-pair UTP cable indicated.
 - 2) One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.
 - c. Mounting: Recessed in ceiling **OR** Wall **OR** Desk **OR** Furniture, **as directed**.
 - d. NRTL listed as complying with UL 50 and UL 1863.
 - e. Label shall include maximum length of work area cords, based on TIA/EIA-568-B.1.
 - f. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

K. Telecommunications Outlet/Connectors

1. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.
2. Workstation Outlets: Two **OR** Four, **as directed**, -port-connector assemblies mounted in single or multigang faceplate.
 - a. Plastic Faceplate: High-impact plastic. Coordinate color with Division 26 Section "Wiring Devices".
 - b. Metal Faceplate: Stainless steel **OR** Brass, **as directed**, complying with requirements in Division 26 Section "Wiring Devices".
 - c. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
 - 1) Flush mounting jacks, positioning the cord at a 45-degree angle.
 - d. Legend:
 - 1) Factory labeled by silk-screening or engraving for stainless steel **OR** brass, **as directed**, faceplates.
OR
Machine printed, in the field, using adhesive-tape label.
OR
Snap-in, clear-label covers and machine-printed paper inserts.

L. Grounding

1. Comply with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems" for grounding conductors and connectors.
2. Comply with ANSI-J-STD-607-A.

M. Identification Products

1. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
2. Comply with requirements in Division 26 Section "Identification For Electrical Systems".

N. Cable Management System

1. Description: Computer-based cable management system, with integrated database and graphic, **as directed**, capabilities.
2. Document physical characteristics by recording the network, TIA/EIA details, and connections between equipment and cable.
3. Information shall be presented in database view, schematic plans, or technical drawings.
 - a. Microsoft Visio Professional or AutoCAD drawing software shall be used as drawing and schematic plans software.
4. System shall interface with the following testing and recording devices:
 - a. Direct upload tests from circuit testing instrument into the personal computer.
 - b. Direct download circuit labeling into labeling printer.

O. Source Quality Control

1. Testing Agency: Engage a qualified testing agency to evaluate cables.
2. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.
3. Factory test UTP cables according to TIA/EIA-568-B.2.
4. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.
5. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.
6. Cable will be considered defective if it does not pass tests and inspections.
7. Prepare test and inspection reports.

1.3 EXECUTION

A. Entrance Facilities

1. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.
- B. Wiring Methods
1. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
 - a. Install plenum cable in environmental air spaces, including plenum ceilings.
 - b. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
 2. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
 3. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- C. Installation Of Pathways
1. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.
 2. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings". Drawings indicate general arrangement of pathways and fittings.
 3. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
 4. Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems" for installation of conduits and wireways.
 5. Install manufactured conduit sweeps and long-radius elbows whenever possible.
 6. Pathway Installation in Communications Equipment Rooms:
 - a. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
 - b. Install cable trays to route cables if conduits cannot be located in these positions.
 - c. Secure conduits to backboard when entering room from overhead.
 - d. Extend conduits **3 inches (76 mm)** above finished floor.
 - e. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
 7. Backboards: Install backboards with **96-inch (2440-mm)** dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.
- D. Installation Of Cables
1. Comply with NECA 1.
 2. General Requirements for Cabling:
 - a. Comply with TIA/EIA-568-B.1.
 - b. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 - c. Install 110-style IDC termination hardware unless otherwise indicated.
 - d. MUTOA shall not be used as a cross-connect point.
 - e. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:
 - 1) Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
 - 2) Locate consolidation points for UTP at least **49 feet (15 m)** from communications equipment room.
 - f. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

- g. Cables may not be spliced. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- h. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- i. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
- j. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
- k. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
- l. In the communications equipment room, install a **10-foot- (3-m-)** long service loop on each end of cable.
- m. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- 3. UTP Cable Installation:
 - a. Comply with TIA/EIA-568-B.2.
 - b. Do not untwist UTP cables more than **1/2 inch (12 mm)** from the point of termination to maintain cable geometry.
- 4. Optical Fiber Cable Installation:
 - a. Comply with TIA/EIA-568-B.3.
 - b. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
- 5. Open-Cable Installation:
 - a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 - b. Suspend UTP cable not in a wireway or pathway a minimum of **8 inches (200 mm)** above ceilings by cable supports not more than **60 inches (1524 mm)** apart.
 - c. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- 6. Installation of Cable Routed Exposed under Raised Floors:
 - a. Install plenum-rated cable only.
 - b. Install cabling after the flooring system has been installed in raised floor areas.
 - c. Coil cable **6 feet (1800 mm)** long not less than **12 inches (300 mm)** in diameter below each feed point.
- 7. Outdoor Coaxial Cable Installation:
 - a. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
 - b. Attach antenna lead-in cable to support structure at intervals not exceeding **36 inches (915 mm)**.
- 8. Group connecting hardware for cables into separate logical fields.
- 9. Separation from EMI Sources:
 - a. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 - b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of **5 inches (127 mm)**.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of **12 inches (300 mm)**.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of **24 inches (610 mm)**.
 - c. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of **2-1/2 inches (64 mm)**.

- 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of **6 inches (150 mm)**.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of **12 inches (300 mm)**.
 - d. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of **3 inches (76 mm)**.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of **6 inches (150 mm)**.
 - e. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of **48 inches (1200 mm)**.
 - f. Separation between Communications Cables and Fluorescent Fixtures: A minimum of **5 inches (127 mm)**.
- E. Firestopping
1. Comply with requirements in Division 07 Section "Penetration Firestopping".
 2. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
 3. Comply with BICSI TDMM, "Firestopping Systems" Article.
- F. Grounding
1. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
 2. Comply with ANSI-J-STD-607-A.
 3. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least **2-inch (50-mm)** clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
 4. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
- G. Identification
1. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".
 - a. Administration Class: **1 OR 2 OR 3 OR 4, as directed**.
 - b. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.
 2. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.
 3. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
 4. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 **OR** Class 3 **OR** Class 4, **as directed**, level of administration, including optional identification requirements of this standard.
 5. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
 6. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and

- equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by the Owner.
7. Cable and Wire Identification:
 - a. Label each cable within **4 inches (100 mm)** of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - b. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 - c. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding **15 feet (4.5 m)**.
 - d. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - 1) Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
 - 2) Label each unit and field within distribution racks and frames.
 - e. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
 - f. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.
 8. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
 - a. Cables use flexible vinyl or polyester that flex as cables are bent.
- H. Field Quality Control
1. Tests and Inspections:
 - a. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
 - b. Visually confirm Category 5e **OR** Category 6, **OR** Category 6e **as directed**, marking of outlets, cover plates, outlet/connectors, and patch panels.
 - c. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - d. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - 1) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - e. Optical Fiber Cable Tests:
 - 1) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - 2) Link End-to-End Attenuation Tests:
 - a) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
 - b) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.
 - f. UTP Performance Tests:

- 1) Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
 - a) Wire map.
 - b) Length (physical vs. electrical, and length requirements).
 - c) Insertion loss.
 - d) Near-end crosstalk (NEXT) loss.
 - e) Power sum near-end crosstalk (PSNEXT) loss.
 - f) Equal-level far-end crosstalk (ELFEXT).
 - g) Power sum equal-level far-end crosstalk (PSELFEXT).
 - h) Return loss.
 - i) Propagation delay.
 - j) Delay skew.
- g. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.3.
- h. Coaxial Cable Tests: Conduct tests according to Division 27 Section "Master Antenna Television System".
- i. Final Verification Tests: Perform verification tests for UTP and optical fiber systems after the complete communications cabling and workstation outlet/connectors are installed.
 - 1) Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
 - 2) Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.
2. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
3. End-to-end cabling will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

END OF SECTION 26 05 19 16h

SECTION 26 05 19 16i - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

1.1 GENERAL

A. Description of Work

1. This specification covers the furnishing and installation of materials for conductors and cables for electronic safety and security. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. UTP cabling.
 - b. 50/125 and 62.5/125-micrometer, multimode optical fiber cabling.
 - c. Coaxial cabling.
 - d. RS-232 cabling.
 - e. RS-485 cabling.
 - f. Low-voltage control cabling.
 - g. Control-circuit conductors.
 - h. Fire alarm wire and cable.
 - i. Identification products.

C. Definitions

1. BICSI: Building Industry Consulting Service International.
2. EMI: Electromagnetic interference.
3. IDC: Insulation displacement connector.
4. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
5. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
6. RCDD: Registered Communications Distribution Designer.

D. Performance Requirements

1. Seismic Performance: Pathways 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."

E. Submittals

1. Product Data: For each type of product indicated.
 - a. For coaxial cable, include the following installation data for each type used:
 - 1) Nominal OD.
 - 2) Minimum bending radius.
 - 3) Maximum pulling tension.
2. Shop Drawings: Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - a. Vertical and horizontal offsets and transitions.
 - b. Clearances for access above and to side of cable trays.
 - c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
3. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
4. Seismic Qualification Certificates: For pathways, 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.
- 5. Source quality-control reports.
- 6. Field quality-control reports.
- 7. Operation and Maintenance Data: For wire and cable to include in operation and maintenance manuals. Include the following:
 - a. Allowable pulling tension of cable.
 - b. Cable connectors and terminations recommended by the manufacturer.

F. Quality Assurance

- 1. Testing Agency Qualifications: An NRTL.
 - a. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD **OR** possess the standards and experience for membership, **as directed**, to supervise on-site testing.
- 2. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.
- 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Delivery, Storage, And Handling

- 1. Test cables upon receipt at Project site.
 - a. Test optical fiber cable to determine the continuity of the strand end to end. Use optical-fiber flashlight or optical loss test set.
 - b. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
 - c. Test each pair of UTP cable for open and short circuits.

H. Project Conditions

- 1. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.
 - a. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.
- 2. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.2 PRODUCTS

A. Pathways

- 1. Support of Open Cabling: NRTL labeled for support of Category 5e **OR** Category 6, **OR** Category 6e **as directed**, cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
 - a. Support brackets with cable tie slots for fastening cable ties to brackets.
 - b. Lacing bars, spools, J-hooks, and D-rings.
 - c. Straps and other devices.
- 2. Cable Trays:

- a. Cable Tray Materials: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than **0.000472 inch (0.012 mm)** thick **OR** hot-dip galvanizing, complying with ASTM A 123/A 123M Grade 0.55, not less than **0.002165 inch (0.055 mm)** thick, **as directed**.
 - 1) Basket Cable Trays: **6 inches (150 mm)** wide and **2 inches (50 mm)** deep, **as directed**. Wire mesh spacing shall not exceed **2 by 4 inches (50 by 100 mm)**.
 - 2) Trough Cable Trays: Nominally **6 inches (150 mm)**, **as directed**, wide.
 - 3) Ladder Cable Trays: Nominally **18 inches (455 mm)**, **as directed**, wide, and a rung spacing of **12 inches (305 mm)**, **as directed**.
 - 4) Channel Cable Trays: One-piece construction, nominally **4 inches (100 mm)**, **as directed**, wide. Slot spacing shall not exceed **4-1/2 inches (115 mm)** o.c.
 - 5) Solid-Bottom Cable Trays: One-piece construction, nominally **12 inches (305 mm)**, **as directed**, wide. Provide with **OR** without, **as directed**, solid covers.
 3. Conduit and Boxes: Comply with requirements in Division 16 Section "Raceways and Boxes." Flexible metal conduit shall not be used, **as directed**.
 4. Outlet boxes shall be no smaller than **2 inches (50 mm)** wide, **3 inches (75 mm)** high, and **2-1/2 inches (64 mm)** deep.
- B. Backboards
1. Backboards: Plywood, fire-retardant treated, **as directed**, **3/4 by 48 by 96 inches (19 by 1220 by 2440 mm)**. Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry".
- C. UTP Cable
1. Description: 100-ohm, 4-pair UTP, covered with a blue thermoplastic jacket.
 - a. Comply with ICEA S-90-661 for mechanical properties.
 - b. Comply with TIA/EIA-568-B.1 for performance specifications.
 - c. Comply with TIA/EIA-568-B.2, Category 5e **OR** Category 6, **OR** Category 6e **as directed**.
 - d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - 1) Communications, General Purpose: Type CM or CMG; **OR** MPP, CMP, MPR, CMR, MP, or MPG, **as directed**.
 - 2) Communications, Plenum Rated: Type CMP **OR** MPP, **as directed**, complying with NFPA 262.
 - 3) Communications, Riser Rated: Type CMR; **OR** MPP, CMP, or MPR, **as directed**, complying with UL 1666.
 - 4) Communications, Limited Purpose: Type CMX; **OR** MPP, CMP, MPR, CMR, MP, MPG, CM, or CMG, **as directed**.
 - 5) Multipurpose: Type MP or MPG; **OR** MPP or MPR, **as directed**.
 - 6) Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
 - 7) Multipurpose, Riser Rated: Type MPR **OR** MPP, **as directed**, complying with UL 1666.
- D. UTP Cable Hardware
1. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.
 2. Connecting Blocks: 110-style for Category 5e **OR** 110-style for Category 6 **OR** 66-style for Category 5e, **OR** 110-style for Category 6e **as directed**. Provide blocks for the number of cables terminated on the block, plus 25, **as directed**, percent spare. Integral with connector bodies, including plugs and jacks where indicated.
- E. Optical Fiber Cable
1. Description: Multimode, 50/125 **OR** 62.5/125, **as directed**,-micrometer, 24-fiber, **as directed**, nonconductive, **as directed**, tight buffer, optical fiber cable.

- a. Comply with ICEA S-83-596 for indoor cable OR ICEA S-87-640 for outside plant, as directed, for mechanical properties.
- b. Comply with TIA/EIA-568-B.3 for performance specifications.
- c. Comply with TIA-492AAAB **OR** TIA-492AAAA-A, **as directed**, for detailed specifications.
- d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - 1) General Purpose, Nonconductive: Type OFN or OFNG, **OR** OFNR, OFNP, **as directed**.
 - 2) Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
 - 3) Riser Rated, Nonconductive: Type OFNR or OFNP, complying with UL 1666.
 - 4) General Purpose, Conductive: Type OFC or OFCG; **OR** OFNG, OFN, OFCR, OFNR, OFCP, or OFNP, **as directed**.
 - 5) Plenum Rated, Conductive: Type OFCP or OFNP, complying with NFPA 262.
 - 6) Riser Rated, Conductive: Type OFCR; or OFNR, OFCP, or OFNP, **asa directed**, complying with UL 1666.
- e. Conductive cable shall be steel **OR** aluminum, **as directed**, armored type.
- f. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
- g. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
2. Jacket:
 - a. Jacket Color: Aqua for 50/125-micrometer cable **OR** Orange for 62.5/125-micrometer cable, **as directed**.
 - b. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
 - c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inches (1000 mm)**.

F. Optical Fiber Cable Hardware

1. Cable Connecting Hardware: Meet the Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
 - a. Quick-connect, simplex and duplex, Type SC **OR** Type ST **OR** Type LC **OR** Type MT-RJ, **as directed**, connectors. Insertion loss not more than 0.75 dB.
 - b. Type SFF connectors may be used in termination racks, panels, and equipment packages.

G. Coaxial Cable

1. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.
2. RG-11/U: NFPA 70, Type CATV.
 - a. No. 14 AWG, solid, copper-covered steel conductor.
 - b. Gas-injected, foam-PE insulation.
 - c. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
 - d. Jacketed with sunlight-resistant, black PVC or PE.
 - e. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg C.
3. RG59/U: NFPA 70, Type CATVR.
 - a. No. 20 AWG, solid, silver-plated, copper-covered steel conductor.
 - b. Gas-injected, foam-PE insulation.
 - c. Triple shielded with 100 percent aluminum polyester tape and 95 percent aluminum braid; covered by aluminum foil with grounding strip.
 - d. Color-coded PVC jacket.
4. RG-6/U: NFPA 70, Type CATV or CM.
 - a. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
 - b. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
 - c. Jacketed with black PVC or PE.

- d. Suitable for indoor installations.
- 5. RG59/U: NFPA 70, Type CATV.
 - a. No. 20 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
 - b. Double shielded with 100 percent aluminum polyester tape and 40 percent aluminum braid.
 - c. PVC jacket.
- 6. RG59/U (Plenum Rated): NFPA 70, Type CMP.
 - a. No. 20 AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
 - b. Double shielded with 100 percent aluminum-foil shield and 65 percent aluminum braid.
 - c. Copolymer jacket.
- 7. NFPA and UL Compliance: Coaxial cables shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655, and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:
 - a. CATV Cable: Type CATV, **OR** CATVP or CATVR, **as directed**.
 - b. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
 - c. CATV Riser Rated: Type CATVR; **OR** CATVP, CATVR, or CATV, **as directed**, complying with UL 1666.
 - d. CATV Limited Rating: Type CATVX.
- H. Coaxial Cable Hardware
 - 1. Coaxial-Cable Connectors: Type BNC, 75 ohms.
- I. RS-232 Cable
 - 1. Standard Cable: NFPA 70, Type CM.
 - a. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - b. Polypropylene insulation.
 - c. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 - d. PVC jacket.
 - e. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - f. Flame Resistance: Comply with UL 1581.
 - 2. Plenum-Rated Cable: NFPA 70, Type CMP.
 - a. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - b. Plastic insulation.
 - c. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 - d. Plastic jacket.
 - e. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - f. Flame Resistance: Comply with NFPA 262.
- J. RS-485 Cable
 - 1. Standard Cable: NFPA 70, Type CM **OR** CMG, **as directed**.
 - a. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - b. PVC insulation.
 - c. Unshielded.
 - d. PVC jacket.
 - e. Flame Resistance: Comply with UL 1581.
 - 2. Plenum-Rated Cable: NFPA 70, Type CMP.
 - a. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - b. Fluorinated ethylene propylene insulation.
 - c. Unshielded.
 - d. Fluorinated ethylene propylene jacket.
 - e. Flame Resistance: NFPA 262, Flame Test.
- K. Low-Voltage Control Cable

1. Paired Cable: NFPA 70, Type CMG.
 - a. 1 pair, twisted, No. 16 AWG, stranded (19x29) and No. 18 AWG, stranded (19x30) tinned copper conductors.
 - b. PVC insulation.
 - c. Unshielded.
 - d. PVC jacket.
 - e. Flame Resistance: Comply with UL 1581.
 2. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
 - a. 1 pair, twisted, No. 16 AWG, stranded (19x29) and No. 18 AWG, stranded (19x30) tinned copper conductors.
 - b. PVC insulation.
 - c. Unshielded.
 - d. PVC jacket.
 - e. Flame Resistance: Comply with NFPA 262.
- L. Control-Circuit Conductors
1. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway **OR** Type XHHN, complying with UL 44, in raceway, **as directed**.
 2. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway **OR** power-limited cable, complying with UL 83, concealed in building finishes **OR** power-limited tray cable, complying with UL 83, in cable tray **OR** Type XHHN, complying with UL 44, in raceway, **as directed**.
 3. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.
- M. Fire Alarm Wire And Cable
1. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
 2. Signaling Line Circuits: Twisted, shielded pair, not less than **OR** No. 18 AWG **OR** size as recommended by system manufacturer, **as directed**.
 - a. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.
 3. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - a. Low-Voltage Circuits: No. 16 AWG, minimum.
 - b. Line-Voltage Circuits: No. 12 AWG, minimum.
 - c. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket, **as directed**, with red identifier stripe, NRTL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.
- N. Identification Products
1. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
 2. Comply with requirements in Division 26 Section "Identification For Electrical Systems".
- O. Source Quality Control
1. Testing Agency: Engage a qualified testing agency to evaluate cables.
 2. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.
 3. Factory test UTP cables according to TIA/EIA-568-B.2.
 4. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA/EIA-568-B.3.

5. Factory sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.
6. Cable will be considered defective if it does not pass tests and inspections.
7. Prepare test and inspection reports.

1.3 EXECUTION

A. Installation Of Pathways

1. Cable Trays: Comply with NEMA VE 2 and TIA-569-B.
2. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.
3. Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems" for installation of conduits and wireways.
4. Install manufactured conduit sweeps and long-radius elbows whenever possible.
5. Pathway Installation in Equipment Rooms:
 - a. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
 - b. Install cable trays to route cables if conduits cannot be located in these positions.
 - c. Secure conduits to backboard when entering room from overhead.
 - d. Extend conduits **3 inches (75 mm)** above finished floor.
 - e. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
6. Backboards: Install backboards with **96-inch (2440-mm)** dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

B. Installation Of Hangers And Supports

1. Comply with requirements in Division 26 Section "Hangers And Supports For Electrical Systems" for installation of supports for pathways, conductors and cables.

C. Wiring Method

1. Install wiring in metal raceways and wireways. Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be **3/4 inch (21 mm)**. Control and data transmission wiring shall not share conduit with other building wiring systems.
2. Install wiring in raceways except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be **3/4 inch (21 mm)**. Control and data transmission wiring shall not share conduit with other building wiring systems.
3. Install cable, concealed in accessible ceilings, walls, and floors when possible.
4. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Installation Of Conductors And Cables

1. Comply with NECA 1.
2. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.
3. General Requirements for Cabling:
 - a. Comply with TIA/EIA-568-B.1.
 - b. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."

- c. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
- d. Cables may not be spliced. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- e. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
- f. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
- g. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
- h. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- 4. UTP Cable Installation: Install using techniques, practices, and methods that are consistent with Category 5e **OR** Category 6, **OR** Category 6e **as directed**, rating of components and that ensure Category 5e **OR** Category 6, **OR** Category 6e **as directed**, performance of completed and linked signal paths, end to end.
 - a. Comply with TIA/EIA-568-B.2.
 - b. Install 110-style IDC termination hardware unless otherwise indicated.
 - c. Do not untwist UTP cables more than **1/2 inch (12 mm)** from the point of termination to maintain cable geometry.
- 5. Optical Fiber Cable Installation:
 - a. Comply with TIA/EIA-568-B.3.
 - b. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.
- 6. Outdoor Coaxial Cable Installation:
 - a. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
 - b. Attach antenna lead-in cable to support structure at intervals not exceeding **36 inches (915 mm)**.
- 7. Open-Cable Installation:
 - a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 - b. Suspend copper cable not in a wireway or pathway a minimum of **8 inches (200 mm)** above ceilings by cable supports not more than **60 inches (1525 mm)** apart.
 - c. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- 8. Installation of Cable Routed Exposed under Raised Floors:
 - a. Install plenum-rated cable only.
 - b. Install cabling after the flooring system has been installed in raised floor areas.
 - c. Coil cable **72 inches (1830 mm)** long shall be neatly coiled not less than **12 inches (300 mm)** in diameter below each feed point.
- 9. Separation from EMI Sources:
 - a. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 - b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of **5 inches (127 mm)**.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of **12 inches (300 mm)**.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of **24 inches (600 mm)**.

- c. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of **2-1/2 inches (64 mm)**.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of **6 inches (150 mm)**.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of **12 inches (300 mm)**.
 - d. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of **3 inches (75 mm)**.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of **6 inches (150 mm)**.
 - e. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of **48 inches (1200 mm)**.
 - f. Separation between Cables and Fluorescent Fixtures: A minimum of **5 inches (127 mm)**.
- E. Fire Alarm Wiring Installation
1. Comply with NECA 1 and NFPA 72.
 2. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceway And Boxes For Electrical Systems".
 - a. Install plenum cable in environmental air spaces, including plenum ceilings.
 - b. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.
 3. Wiring Method:
 - a. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
 - b. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, is **OR** is not, **as directed**, permitted.
 - c. Signaling Line Circuits: Power-limited fire alarm cables may **OR** shall not, **as directed**, be installed in the same cable or raceway as signaling line circuits.
 4. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
 5. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
 6. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
 7. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.
 8. Wiring to Remote Alarm Transmitting Device: **1-inch (25-mm)** conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.
- F. Power And Control-Circuit Conductors
1. 120-V Power Wiring: Install according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables" unless otherwise indicated.
 2. Minimum Conductor Sizes:
 - a. Class 1 remote-control and signal circuits, No. 14 AWG.

- b. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
- c. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

G. Connections

- 1. Comply with requirements in Division 28 Section "Perimeter Security Systems" for connecting, terminating, and identifying wires and cables.
- 2. Comply with requirements in Division 28 Section "Intrusion Detection" for connecting, terminating, and identifying wires and cables.
- 3. Comply with requirements in Division 28 Section "Access Control" for connecting, terminating, and identifying wires and cables.
- 4. Comply with requirements in Division 28 Section "Video Surveillance" for connecting, terminating, and identifying wires and cables.
- 5. Comply with requirements in Division 28 Section "Plc Electronic Detention Monitoring And Control Systems" for connecting, terminating, and identifying wires and cables.
- 6. Comply with requirements in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System", **as directed**, for connecting, terminating, and identifying wires and cables.
- 7. Comply with requirements in Division 28 Section "Refrigerant Detection And Alarm" for connecting, terminating, and identifying wires and cables.

H. Firestopping

- 1. Comply with requirements in Division 07 Section "Penetration Firestopping".
- 2. Comply with TIA-569-B, "Firestopping" Annex A.
- 3. Comply with BICSI TDMM, "Firestopping Systems" Article.

I. Grounding

- 1. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- 2. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".

J. Identification

- 1. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".

K. Field Quality Control

- 1. Perform tests and inspections.
- 2. Tests and Inspections:
 - a. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
 - b. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - c. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.
 - 1) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - d. Optical Fiber Cable Tests:

- 1) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- 2) Link End-to-End Attenuation Tests:
 - a) Multimode Link Measurements: Test at 850 or 1300 nm in 1 direction according to TIA-526-14-A, Method B, One Reference Jumper.
 - b) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.
- e. Coaxial Cable Tests: Comply with requirements in Division 27 Section "Master Antenna Television System".
3. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
4. End-to-end cabling will be considered defective if it does not pass tests and inspections.
5. Prepare test and inspection reports.

END OF SECTION 26 05 19 16i

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Task	Specification	Specification Description
26 05 19 16	26 05 00 00	Common Work Results for Electrical

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SECTION 26 05 23 00 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of control-voltage electrical power cables. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. UTP cabling.
 - b. 50/125 **OR** 62.5/125, **as directed**,-micrometer, multimode optical fiber cabling.
 - c. RS-232 cabling.
 - d. RS-485 cabling.
 - e. Low-voltage control cabling.
 - f. Control-circuit conductors.
 - g. Identification products.

C. Definitions

1. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
2. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel section.
3. EMI: Electromagnetic interference.
4. IDC: Insulation displacement connector.
5. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
6. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
7. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
8. RCDD: Registered Communications Distribution Designer.
9. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal side rails, and a bottom without ventilation openings.
10. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.
11. UTP: Unshielded twisted pair.

D. Submittals

1. Product Data: For each type of product indicated.
2. Field quality-control reports.
3. Maintenance data.

E. Quality Assurance

1. Testing Agency Qualifications: Member company of an NRTL.
 - a. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing **OR** possess the standards and experience for membership, **as directed**.
2. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.

3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Delivery, Storage, And Handling

1. Test cables upon receipt at Project site.
 - a. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight **OR** optical loss test set, **as directed**.
 - b. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
 - c. Test each pair of UTP cable for open and short circuits.

1.2 PRODUCTS

A. Pathways

1. Support of Open Cabling: NRTL labeled for support of Category 5e **OR** Category 6, **as directed**, cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
 - a. Support brackets with cable tie slots for fastening cable ties to brackets.
 - b. Lacing bars, spools, J-hooks, and D-rings.
 - c. Straps and other devices.
2. Cable Trays:
 - a. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than **0.000472 inch (0.012 mm)** thick **OR** hot-dip galvanizing, complying with ASTM A 123/A 123M, Grade 0.55, not less than **0.002165 inch (0.055 mm)** thick, **as directed**.
 - 1) Basket Cable Trays: **6 inches (150 mm)** wide and **2 inches (50 mm)** deep. Wire mesh spacing shall not exceed **2 by 4 inches (50 by 100 mm)**.
 - 2) Trough or Ventilated Cable Trays: Nominally **6 inches (150 mm)** wide.
 - 3) Ladder Cable Trays: Nominally **18 inches (455 mm)** wide, and a rung spacing of **12 inches (305 mm)**.
 - 4) Channel Cable Trays: One-piece construction, nominally **4 inches (100 mm)** wide. Slot spacing shall not exceed **4-1/2 inches (115 mm)** o.c.
 - 5) Solid-Bottom or Nonventilated Cable Trays: One-piece construction, nominally **12 inches (305 mm)** wide. Provide with **OR** without, **as directed**, solid covers.
3. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems". Flexible metal conduit shall not be used, **as directed**.
 - a. Outlet boxes shall be no smaller than **2 inches (50 mm)** wide, **3 inches (75 mm)** high, and **2-1/2 inches (64 mm)** deep.

B. Backboards

1. Description: Plywood, fire-retardant treated, **as directed**, **3/4 by 48 by 96 inches (19 by 1220 by 2440 mm)**. Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry".

C. UTP Cable

1. Description: 100-ohm, four-pair UTP, formed into 25-pair binder groups covered with a blue thermoplastic jacket, **as directed**.
 - a. Comply with ICEA S-90-661 for mechanical properties.
 - b. Comply with TIA/EIA-568-B.1 for performance specifications.
 - c. Comply with TIA/EIA-568-B.2, Category 5e **OR** Category 6, **as directed**.
 - d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

- 1) Communications, General Purpose: Type CM or Type CMG; or Type MPP, Type CMP, Type MPR, Type CMR, Type MP, or Type MPG, **as directed**.
- 2) Communications, Plenum Rated: Type CMP or Type MPP, **as directed**, complying with NFPA 262.
- 3) Communications, Riser Rated: Type CMR; or Type MPP, Type CMP, or Type MPR, **as directed**; complying with UL 1666.
- 4) Communications, Limited Purpose: Type CMX; or Type MPP, Type CMP, Type MPR, Type CMR, Type MP, Type MPG, Type CM, or Type CMG, **as directed**.
- 5) Multipurpose: Type MP or Type MPG; or Type MPP or Type MPR, **as directed**.
- 6) Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
- 7) Multipurpose, Riser Rated: Type MPR or Type MPP, **as directed**, complying with UL 1666.

D. UTP Cable Hardware

1. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.
2. Connecting Blocks: 110 style for Category 5e **OR** 110 style for Category 6 **OR** 66 style for Category 5e, **as directed**. Provide blocks for the number of cables terminated on the block, plus 25 percent spare; integral with connector bodies, including plugs and jacks where indicated.

E. Optical Fiber Cable

1. Description: Multimode, 50/125 **OR** 62.5/125, **as directed**, -micrometer, 24-fiber, nonconductive, **as directed**, tight buffer, optical fiber cable.
 - a. Comply with ICEA S-83-596 for mechanical properties.
 - b. Comply with TIA/EIA-568-B.3 for performance specifications.
 - c. Comply with TIA/EIA-492AAAA-B **OR** TIA/EIA-492AAAA-A, **as directed**, for detailed specifications.
 - d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - 1) General Purpose, Nonconductive: Type OFN or OFNG, or Type OFNR or Type OFNP, **as directed**.
 - 2) Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
 - 3) Riser Rated, Nonconductive: Type OFNR or Type OFNP, **as directed**, complying with UL 1666.
 - 4) General Purpose, Conductive: Type OFC or Type OFCG; or Type OFNG, Type OFN, Type OFCR, Type OFNR, Type OFCP, or Type OFNP, **as directed**.
 - 5) Plenum Rated, Conductive: Type OFCP or Type OFNP, **as directed**, complying with NFPA 262.
 - 6) Riser Rated, Conductive: Type OFCR; or Type OFNR, Type OFCP, or Type OFNP, **as directed**; complying with UL 1666.
 - e. Conductive cable shall be steel **OR** aluminum, **as directed**, -armored type.
 - f. Maximum Attenuation: 3.5 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
 - g. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
2. Jacket:
 - a. Jacket Color: Aqua for 50/125 **OR** Orange for 62.5/125, **as directed**, -micrometer cable.
 - b. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
 - c. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed **40 inches (1000 mm)**.

F. Optical Fiber Cable Hardware

1. Cable Connecting Hardware: Comply with the Fiber Optic Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
 - a. Quick-connect, simplex and duplex, Type SC **OR** Type ST **OR** Type LC **OR** Type MT-RJ, **as directed**, connectors. Insertion loss not more than 0.75 dB.
 - b. Type SFF connectors may be used in termination racks, panels, and equipment packages.

G. RS-232 Cable

1. **Standard Cable: NFPA 70, Type CM.**
 - a. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
 - b. Polypropylene insulation.
 - c. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 - d. PVC jacket.
 - e. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
 - f. Flame Resistance: Comply with UL 1581.
2. **Plenum-Rated Cable: NFPA 70, Type CMP.**
 - a. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
 - b. Plastic insulation.
 - c. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 - d. Plastic jacket.
 - e. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
 - f. Flame Resistance: Comply with NFPA 262.

H. RS-485 Cable

1. **Standard Cable: NFPA 70, Type CM or Type CMG, as directed.**
 - a. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
 - b. PVC insulation.
 - c. Unshielded.
 - d. PVC jacket.
 - e. Flame Resistance: Comply with UL 1581.
2. **Plenum-Rated Cable: NFPA 70, Type CMP.**
 - a. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
 - b. Fluorinated ethylene propylene insulation.
 - c. Unshielded.
 - d. Fluorinated ethylene propylene jacket.
 - e. Flame Resistance: NFPA 262, Flame Test.

I. Low-Voltage Control Cable

1. **Paired Cable: NFPA 70, Type CMG.**
 - a. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
 - b. PVC insulation.
 - c. Unshielded.
 - d. PVC jacket.
 - e. Flame Resistance: Comply with UL 1581.
2. **Plenum-Rated, Paired Cable: NFPA 70, Type CMP.**
 - a. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
 - b. PVC insulation.
 - c. Unshielded.
 - d. PVC jacket.
 - e. Flame Resistance: Comply with NFPA 262.
3. **Paired Cable: NFPA 70, Type CMG.**
 - a. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
 - b. PVC insulation.
 - c. Unshielded.
 - d. PVC jacket.
 - e. Flame Resistance: Comply with UL 1581.
4. **Plenum-Rated, Paired Cable: NFPA 70, Type CMP.**
 - a. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
 - b. Fluorinated ethylene propylene insulation.
 - c. Unshielded.

- d. Plastic jacket.
 - e. Flame Resistance: NFPA 262, Flame Test.
- J. Control-Circuit Conductors
- 1. Class 1 Control Circuits: Stranded copper, Type THHN-THWN **OR** Type XHHN, **as directed**, in raceway, complying with UL 83 **OR** UL 44, **as directed**.
 - 2. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway **OR** Type XHHN, in raceway **OR** power-limited cable, concealed in building finishes **OR** power-limited tray cable, in cable tray, **as directed**, complying with UL 83 **OR** UL 44, **as directed**.
 - 3. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.
- K. Identification Products
- 1. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
 - 2. Comply with requirements in Division 26 Section "Identification For Electrical Systems".
- L. Source Quality Control
- 1. Testing Agency: Engage a qualified testing agency to evaluate cables.
 - 2. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.
 - 3. Factory test UTP cables according to TIA/EIA-568-B.2.
 - 4. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.
 - 5. Cable will be considered defective if it does not pass tests and inspections.
 - 6. Prepare test and inspection reports.

1.3 EXECUTION

- A. Installation Of Pathways
- 1. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.
 - 2. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
 - 3. Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems" for installation of conduits and wireways.
 - 4. Install manufactured conduit sweeps and long-radius elbows if possible.
 - 5. Pathway Installation in Equipment Rooms:
 - a. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed or in the corner of room if multiple sheets of plywood are installed around perimeter walls of room.
 - b. Install cable trays to route cables if conduits cannot be located in these positions.
 - c. Secure conduits to backboard if entering room from overhead.
 - d. Extend conduits **3 inches (75 mm)** above finished floor.
 - e. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
 - 6. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.
- B. Installation Of Conductors And Cables
- 1. Comply with NECA 1.
 - 2. General Requirements for Cabling:
 - a. Comply with TIA/EIA-568-B.1.
 - b. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 - c. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.

- d. Cables may not be spliced. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- e. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
- f. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
- g. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
- h. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
3. UTP Cable Installation:
 - a. Comply with TIA/EIA-568-B.2.
 - b. Install 110-style IDC termination hardware unless otherwise indicated.
 - c. Do not untwist UTP cables more than **1/2 inch (12 mm)** from the point of termination to maintain cable geometry.
4. Installation of Control-Circuit Conductors:
 - a. Install wiring in raceways. Comply with requirements specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
5. Optical Fiber Cable Installation:
 - a. Comply with TIA/EIA-568-B.3.
 - b. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.
6. Open-Cable Installation:
 - a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 - b. Suspend copper cable not in a wireway or pathway a minimum of **8 inches (200 mm)** above ceilings by cable supports not more than **60 inches (1525 mm)** apart.
 - c. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
7. Installation of Cable Routed Exposed under Raised Floors:
 - a. Install plenum-rated cable only.
 - b. Install cabling after the flooring system has been installed in raised floor areas.
 - c. Coil cable **72 inches (1830 mm)** long shall be neatly coiled not less than **12 inches (305 mm)** in diameter below each feed point.
8. Separation from EMI Sources:
 - a. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 - b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of **5 inches (127 mm)**.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of **12 inches (305 mm)**.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of **24 inches (600 mm)**.
 - c. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of **2-1/2 inches (64 mm)**.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of **6 inches (150 mm)**.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of **12 inches (305 mm)**.
 - d. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

- 1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of **3 inches (75 mm)**.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of **6 inches (150 mm)**.
 - e. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of **48 inches (1200 mm)**.
 - f. Separation between Cables and Fluorescent Fixtures: A minimum of **5 inches (127 mm)**.
- C. Removal Of Conductors And Cables
 1. Remove abandoned conductors and cables.
- D. Control-Circuit Conductors
 1. Minimum Conductor Sizes:
 - a. Class 1 remote-control and signal circuits, No 14 AWG.
 - b. Class 2 low-energy, remote-control, and signal circuits, No. 16 AWG.
 - c. Class 3 low-energy, remote-control, alarm, and signal circuits, No 12 AWG.
- E. Firestopping
 1. Comply with requirements in Division 07 Section "Penetration Firestopping".
 2. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
 3. Comply with BICSI TDMM, "Firestopping Systems" Article.
- F. Grounding
 1. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
 2. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".
- G. Identification
- H. Identify system components, wiring, and cabling according to TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".
- I. Field Quality Control
 1. Perform tests and inspections.
 2. Tests and Inspections:
 - a. Visually inspect UTP and optical fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
 - b. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - c. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross connection.
 - 1) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - d. Optical Fiber Cable Tests:
 - 1) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - 2) Link End-to-End Attenuation Tests:
 - a) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.

- b) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.
- 3. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- 4. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- 5. Prepare test and inspection reports.

END OF SECTION 26 05 23 00

SECTION 26 05 26 00 - LIGHTNING PROTECTION

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for lightning 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 lightning protection for structures, structure elements and building site components.

C. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: For air terminals and mounting accessories.
 - a. Layout of the lightning protection system, along with details of the components to be used in the installation.
 - b. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
3. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.
4. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.
5. Field quality-control reports.
6. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.
7. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
 - a. Ground rods.
 - b. Ground loop conductor.

D. Quality Assurance

1. Installer Qualifications: Certified by UL or LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.
2. System Certificate:
 - a. UL Master Label.
OR
LPI System Certificate.
OR
UL Master Label Recertification.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

E. Coordination

1. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
2. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
3. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

1.2 PRODUCTS

- A. Lightning Protection System Components
1. Comply with UL 96 and NFPA 780, **as directed**.
 2. Roof-Mounted Air Terminals: NFPA 780, Class I **OR** Class II, **as directed**, aluminum **OR** copper, **as directed**, unless otherwise indicated.
 - a. Air Terminals More than **24 Inches (600 mm)** Long: With brace attached to the terminal at not less than half the height of the terminal.
 - b. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in Division 07.
 3. Main and Bonding Conductors: Copper **OR** Aluminum, **as directed**.
 4. Ground Loop Conductor: The same size and type as the main conductor except tinned.
 5. Ground Rods: Copper-clad **OR** Zinc-coated **OR** Stainless, **as directed**, steel, sectional type, **as directed**; **3/4 inch (19 mm)** in diameter by **10 feet (3 m)** **OR** **5/8 inch (16 mm)** in diameter by **96 inches (2400 mm)**, **as directed**, long.
 6. Heavy-Duty, Stack-Mounted, Lightning Protection Components: Stainless steel **OR** Solid copper **OR** Monel metal **OR** Lead sheathed, **as directed**.

1.3 EXECUTION

- A. Installation
1. Install lightning protection components and systems according to UL 96A and NFPA 780.
 2. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
 3. Conceal the following conductors:
 - a. System conductors.
 - b. Down conductors.
 - c. Interior conductors.
 - d. Conductors within normal view of exterior locations at grade within **200 feet (60 m)** of building.
 4. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.
OR
 Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.
 - a. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.
 5. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.
 6. Bond extremities of vertical metal bodies exceeding **60 feet (18 m)** in length to lightning protection components.
 7. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure **OR** area or item indicated, **as directed**.
 - a. Bury ground ring not less than **24 inches (600 mm)** from building foundation.
 - b. Bond ground terminals to the ground loop.
 - c. Bond grounded building systems to the ground loop conductor within **12 feet (3.6 m)** of grade level.
 8. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at **60-foot (18-m)** intervals.
- B. Corrosion Protection
1. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

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- 2. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.
- C. Field Quality Control
- 1. Notify the Owner at least 48 hours in advance of inspection before concealing lightning protection components.
 - 2. UL Inspection: Meet requirements to obtain a UL Master Label for system.
OR
LPI System Inspection: Meet requirements to obtain an LPI System Certificate.

END OF SECTION 26 05 26 00

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SECTION 26 05 26 00a - GROUNDING AND BONDING

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for grounding and bonding. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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 methods and materials for grounding systems and equipment, plus the following special applications, **as directed**:
 - a. Overhead-lines grounding.
 - b. Underground distribution grounding.
 - c. Common ground bonding with lightning protection system.

C. Submittals

1. Product Data: For each type of product indicated.
2. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
 - a. Test wells.
 - b. Ground rods.
 - c. Ground rings.
 - d. Grounding arrangements and connections for separately derived systems.
 - e. Grounding for sensitive electronic equipment.
3. Qualification Data: For qualified testing agency and testing agency's field supervisor.
4. Field quality-control test reports.
5. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation And Maintenance Data", include the following:
 - a. Instructions for periodic testing and inspection of grounding features at test wells **OR** ground rings **OR** grounding connections for separately derived systems, **as directed** based on NETA MTS **OR** NFPA 70B, **as directed**.
 - 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
 - 2) Include recommended testing intervals.

D. Quality Assurance

1. Testing Agency Qualifications: Member company of NETA or an NRTL **OR** one who meets the requirements necessary for certification, **as directed**.
 - a. Testing Agency's Field Supervisor: Currently certified by NETA **OR** one who meets the requirements necessary for certification, **as directed**, to supervise on-site testing.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Comply with UL 467 for grounding and bonding materials and equipment.

1.2 PRODUCTS

A. Conductors

1. Insulated Conductors: Copper **OR** Tinned-copper, **as directed**, wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

2. Bare Copper Conductors:
 - a. Solid Conductors: ASTM B 3.
 - b. Stranded Conductors: ASTM B 8.
 - c. Tinned Conductors: ASTM B 33.
 - d. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, **1/4 inch (6 mm)** in diameter.
 - e. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - f. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; **1-5/8 inches (41 mm)** wide and **1/16 inch (1.6 mm)** thick.
 - g. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; **1-5/8 inches (41 mm)** wide and **1/16 inch (1.6 mm)** thick.
3. Bare Grounding Conductor and Conductor Protector for Wood Poles:
 - a. No. 4 AWG minimum, soft-drawn copper.
 - b. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.
4. Grounding Bus: Predrilled rectangular bars of annealed copper, **1/4 by 2 inches (6 by 50 mm)**, **as directed**, in cross section, with **9/32-inch (7.14-mm)** holes spaced **1-1/8 inches (28 mm)** apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

B. Connectors

1. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
2. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - a. Pipe Connectors: Clamp type, sized for pipe.
3. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
4. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression **OR** exothermic-type wire terminals, **as directed**, and long-barrel, two-bolt connection to ground bus bar.

C. Grounding Electrodes

1. Ground Rods: Copper-clad **OR** Zinc-coated **OR** Stainless, **as directed**, steel, sectional type, **as directed**; **3/4 inch by 10 feet (19 mm by 3 m) OR 5/8 by 96 inches (16 by 2400 mm)**, **as directed**, in diameter.
2. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
 - a. Termination: Factory-attached No. 4/0 AWG bare conductor at least **48 inches (1200 mm)** long.
 - b. Backfill Material: Electrode manufacturer's recommended material.

1.3 EXECUTION

A. Applications

1. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
2. Underground Grounding Conductors: Install bare copper **OR** tinned-copper, **as directed**, conductor, No. 2/0 AWG minimum. Bury at least **24 inches (600 mm)** below grade.
 - a. Bury at least **24 inches (600 mm)** below grade.
 - b. Duct-Bank Grounding Conductor: Bury **12 inches (300 mm)** above duct bank when indicated as part of duct-bank installation.

3. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
 4. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - a. Install bus on insulated spacers **1 inch (25 mm)**, minimum, from wall **6 inches (150 mm)** above finished floor, unless otherwise indicated.
 - b. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
 5. Conductor Terminations and Connections:
 - a. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - b. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
 - c. Connections to Ground Rods at Test Wells: Bolted connectors.
 - d. Connections to Structural Steel: Welded connectors.
- B. Grounding Overhead Lines
1. Comply with IEEE C2 grounding requirements.
 2. Install 2 parallel ground rods if resistance to ground by a single, ground-rod electrode exceeds 25 ohms.
 3. Drive ground rods until tops are **12 inches (300 mm)** below finished grade in undisturbed earth.
 4. Ground-Rod Connections: Install bolted connectors for underground connections and connections to rods.
 5. Lightning Arrester Grounding Conductors: Separate from other grounding conductors.
 6. Secondary Neutral and Transformer Enclosure: Interconnect and connect to grounding conductor.
 7. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communication service and transformer spaces.
- C. Grounding Underground Distribution System Components
1. Comply with IEEE C2 grounding requirements.
 2. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so **4 inches (100 mm)** will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from **2 inches (50 mm)** above to **6 inches (150 mm)** below concrete. Seal floor opening with waterproof, nonshrink grout.
 3. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
 4. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than **6 inches (150 mm)** from the foundation.
- D. Equipment Grounding
1. Install insulated equipment grounding conductors with all feeders and branch circuits.
 2. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - a. Feeders and branch circuits.

- b. Lighting circuits.
 - c. Receptacle circuits.
 - d. Single-phase motor and appliance branch circuits.
 - e. Three-phase motor and appliance branch circuits.
 - f. Flexible raceway runs.
 - g. Armored and metal-clad cable runs.
 - h. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - i. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
 - j. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
3. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
 4. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
 5. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
 6. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
 7. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - a. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a **1/4-by-2-by-12-inch (6-by-50-by-300-mm)** grounding bus.
 - b. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
 8. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

E. Installation

1. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
2. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
3. Ground Rods: Drive rods until tops are **2 inches (50 mm)** below finished floor or final grade, unless otherwise indicated.
 - a. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

- b. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- 4. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts And Raceways For Electrical Systems" and shall be at least **12 inches (300 mm)** deep, with cover.
 - a. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- 5. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - a. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - b. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 - c. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- 6. Grounding and Bonding for Piping:
 - a. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - b. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - c. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- 7. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- 8. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than **60 feet (18 m)** apart.
- 9. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column **OR** indicated item, **as directed**, extending around the perimeter of building **OR** area or item indicated, **as directed**.
 - a. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
 - b. Bury ground ring not less than **24 inches (600 mm)** from building foundation.
- 10. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of **20 feet (6 m)** of bare copper conductor not smaller than No. 4 AWG.
 - a. If concrete foundation is less than **20 feet (6 m)** long, coil excess conductor within base of foundation.
 - b. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

F. Labeling

- 1. Comply with requirements in Division 26 Section "Identification For Electrical Systems" for instruction signs. The label or its text shall be green.
- 2. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
 - a. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

G. Field Quality Control

1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Tests and Inspections:
 - a. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - b. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.
 - 1) Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - 2) Perform tests by fall-of-potential method according to IEEE 81.
 - c. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
3. Report measured ground resistances that exceed the following values:
 - a. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
 - b. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
 - c. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 - d. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 **OR** 3, **as directed**, ohm(s).
 - e. Substations and Pad-Mounted Equipment: 5 ohms.
 - f. Manhole Grounds: 10 ohms.
4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify the Owner promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26 00a

SECTION 26 05 26 00b - OVERHEAD ELECTRICAL DISTRIBUTION

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for overhead electrical 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. Section Includes:
 - a. Conductors, connectors, and splices.
 - b. Poles and crossarms.
 - c. Hardware and accessories.
 - d. Surge arresters.
 - e. Cutouts, switches, and fuses.
 - f. Pole-mounted distribution transformers.
 - g. Primary metering equipment.

C. Definitions

1. BIL: Basic impulse level, stated in kilovolts.
2. RUS: Department of Agriculture, Rural Utilities Service.
3. Sag: The distance measured vertically from a conductor to the straight line joining its two points of support, measured at the midpoint of the span, unless otherwise indicated.
 - a. Final Sag: The sag of a conductor under specified conditions of loading and temperature applied after it has been subjected, for an appreciable period, to the loading prescribed for the loading district in which it is situated, or equivalent loading, and the loading removed. Final sag includes the effect of inelastic deformation (creep).
 - b. Initial Unloaded Sag: The sag of a conductor before the application of an external load.
4. Secondary: Conductors and components for circuits operating at the utilization voltage of 600 V or less.
5. Service: Set of insulated conductors extending from a pole to the metering point or service entrance connection at the location of utilization of electricity.

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. Qualification Data: For qualified manufacturer **OR** testing agency, **as directed**.
3. Material Certificates: For the following items, from manufacturers:
 - a. Wood poles.
 - b. Concrete poles.
 - c. Wood crossarms.
4. Listing Documentation: Indicate that products comply with RUS listing requirements specified in "Quality Assurance" Article.
 - a. Time-Current Coordination Curves: Illustrate optimum coordination of protective devices involved in the Work of this Section.
 - b. Source quality-control test reports.
5. Field quality-control reports.
6. Operation and Maintenance Data: For switches **OR** transformers, **as directed**, to include in emergency, operation, and maintenance manuals.
7. Survey records for locations of pole, anchors, and other features for inclusion in Project Record Documents.

E. Quality Assurance

1. Concrete Pole Manufacturer Qualifications: Certified by PCI as a qualified manufacturer of concrete utility poles of type and size indicated for this Project.
2. Inspection Agency Qualifications for Pole and Crossarm Inspection: An independent agency, acceptable to authorities having jurisdiction, qualified to conduct inspections indicated.
3. Testing Agency Qualifications: Member company of NETA or an NRTL.
4. Testing Agency's Field Supervisor: Currently certified by NETA or an NRTL.
5. Treatment Technician Qualifications for Field Treatment of Wood Poles and Crossarms: Certified by authorities having jurisdiction over environmental protection at the location of Project for field application of chemicals required.
6. 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.
7. Overhead-Line Components, Devices, and Accessories: Currently listed in RUS Informational Publication 202-1 without restriction for the intended application.
8. Comply with IEEE C2 **OR** CPUC General Order 95, **as directed**, except where stricter requirements are indicated or where local requirements that are stricter apply.
9. Strength of Line and Line Components Selected by Contractor: Provide grades of construction and strength required by IEEE C2 for conditions encountered at Project site for heavy **OR** medium **OR** light, **as directed**, line loading unless otherwise indicated.

F. Delivery, Storage, And Handling

1. Wood Pole Storage and Handling: Comply with ATIS O5.1. Do not use pointed handling tools capable of producing indentations greater than 1 inch (25 mm).

G. Project Conditions

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

H. Coordination

1. Coordinate with utility supplying electricity to lines specified in this Section, and make final connections **OR** arrangements for final connections by utility, **as directed**.
2. Coordinate with those responsible for voice **OR** data **OR** video, **as directed**, systems that will have cables supported by poles installed according to this Section.

1.2 PRODUCTS**A. Conductors, Connectors, And Splices**

1. Conductor Type AAC: Bare **OR** Bare and covered, **as directed**, all-aluminum, Alloy 1350-H19, complying with ASTM B 230/B 230M and ASTM B 231/B 231M.
OR
 Conductor Type AAAC: Bare **OR** Bare and covered, **as directed**, all-aluminum-alloy, Alloy 6201-T81, complying with ASTM B 398/B 398M and ASTM B 399/B 399M.
OR
 Conductor Type ACSR: Bare **OR** Bare and covered, **as directed**, aluminum conductor, steel reinforced, complying with ASTM B 232/B 232M.
OR
 Conductor Type CU: Bare **OR** Bare and covered, **as directed**, hard-drawn copper, complying with ASTM B 1 and ASTM B 8.
2. Conductor Covering: UV resistant, complying with ICEA-S-70-547. HDPE **OR** XLP, **as directed**, 150 mils (3.81 mm) thick.

3. Self-Supported, Multiconductor, Insulated Medium-Voltage Wiring: Factory-assembled, messenger-supported type, listed under UL 1072 as sunlight-resistant Type MV cable for cable tray use.
 - a. Conductors: Aluminum, Alloy 1350, complying with ASTM B 230/B 230M and ASTM B 231/B 231M **OR** Hard-drawn copper, complying with ASTM B 1 and ASTM B 8, **as directed**; stranded for No. 2 AWG and larger.
 - b. Conductor Insulation: XLP, complying with NEMA WC 70/ICEA S-95-658 **OR** EPR, complying with NEMA WC 70/ICEA S-95-658, **as directed**.
 - c. Insulation Level: 100 **OR** 133, **as directed**, percent of rated circuit line-to-line voltage.
 - d. Conductor Shield: Extruded, nonconducting, thermoset material, complying with NEMA WC 70/ICEA S-95-658; **18-mil (0.046-mm)** minimum thickness.
 - e. Insulation Shield: Include the following two components:
 - 1) Nonmetallic conducting, material complying with NEMA WC 70/ICEA S-95-658 and UL 1072, extruded over, and free stripping from the insulation.
 - 2) Metallic Tape Shield: Bare copper, **5-mil (0.127-mm)** minimum thickness, helically applied with a 15 percent minimum overlap.
 - f. Conductor Jacket: Extruded, chlorosulfonated-polyethylene-based material, complying with NEMA WC 70/ICEA S-95-658.
 - g. Messenger: Copper **OR** Composite copper and copper, **as directed**, -clad steel.
 - h. Conductor Support Strap: Copper strap, wound around conductors and messenger the full length of the cable.
4. Secondary-Voltage Line Conductors: Aluminum conductor, steel **reinforced**, complying with ASTM B 232/B 232M **OR** Covered aluminum conductor, steel reinforced, complying with ICEA S-70-547, with HDPE or XLP covering, **as directed**, **60 mils (1.52 mm)** thick.
OR
 Secondary-Voltage Line Conductors: Bare hard-drawn copper, complying with ASTM B 1 and ASTM B 8 **OR** Covered hard-drawn copper, complying with ICEA S-70-547, with HDPE or XLP covering, **as directed**, **60 mils (1.52 mm)** thick. Neutral-supported, secondary service-drop cable, **as directed**.
OR
 Racked Secondary Conductors, 600 V and Less: Copper, insulated with XLP, complying with NEMA WC 70/ICEA S-95-658, **as directed**.
5. Neutral-Supported, Secondary Service-Drop Cable, 600 V and Less: Insulated conductors with bare neutral, complying with ICEA S-76-474, and using the following combination of materials:
 - a. Conductors and Neutral: Copper with copper-clad-steel neutral **OR** Aluminum with bare Alloy 1350 aluminum neutral **OR** Aluminum with ACSR neutral, **as directed**.
 - b. Insulation: XLP, complying with NEMA WC 70/ICEA S-95-658 **OR** High-modular-weight, low-density polyethylene **OR** Weather-resistant polyolefin, complying with ICEA S-70-547, **as directed**.
6. Connectors, Splices, and Conductor Securing and Protecting Components: Items include wire clamps, ties, conductor armor, fittings, connectors, and terminals. Listed for the specific applications and conductor types and combinations of materials used. Descriptions as follows for various applications:
 - a. Copper to Copper: Copper alloy, complying with UL 486A-486B.
 - b. Aluminum Composition to Aluminum Composition: Aluminum alloy, complying with UL 486A-486B.
 - c. Copper to Aluminum Composition: Type suitable for this purpose, complying with UL 486A-486B.
 - d. Connectors and Splices for Secondary Conductors: Listed and labeled for the conditions and materials involved in each application.
 - e. Taps for Medium-Voltage Line Conductors: Hot-line clamps, screw type, with concealed threads and bare, hard-drawn copper stirrups. Listed for the combination of materials being connected.
 - f. Splices under Tension: Compression type with strength exceeding the conductors spliced.

- g. Splices and Terminations for Covered Conductors: As recommended by conductor manufacturer for conductor and covering combination and for specific materials and physical arrangement of each splice.
 - h. Splices and Terminations for Insulated Medium-Voltage Conductors: Comply with requirements in Division 26 Section "Medium-voltage Cables".
- B. Wood Poles
- 1. Comply with ATIS O5.1 and RUS Bulletin 1728F-700, for wood poles pressure treated with creosote **OR** pentachlorophenol, **as directed**, **OR** ammoniacal copper arsenate, **OR** ammoniacal copper zinc arsenate **OR** chromated copper arsenate, **as directed**.
 - 2. Wood Species: Douglas fir **OR** Lodgepole pine **OR** Western larch **OR** Southern yellow pine, **as directed**.
 - 3. Pole Marking:
 - a. Manufacturer's Mark: Comply with ATIS O5.1; locate 10 feet (3 m) from the pole butt for poles 50 feet (15 m) long or less.
 - b. Pole Number: Machine-embossed aluminum, alphanumeric characters not less than 2-1/2 inches (65 mm) high, with aluminum nails.
 - 4. Factory Operations: Machine trim poles by turning smooth, full length. Roof, gain, and bore poles before pressure treatment.
- C. Concrete Poles
- 1. Description: Spun-cast prestressed concrete, complying with requirements of ASTM C 1089.
 - a. Comply with requirements of RUS Bulletin 1724E-216.
 - 2. Design: Base design on calculation of strength required by IEEE C2 or indicated on Drawings, whichever is greater. Design shall be suitable for installation at a location where annual temperature range is between minus 4 deg F and plus 100 deg F (minus 20 deg C and plus 38 deg C). Include pole design for embedded attachments matching fittings, brackets, and other items installed in the field.
 - 3. Shaft: Hollow, for poles at overhead-to-underground connections. Provide 3-1/2-inch- (89-mm-) minimum cable raceway capacity, with conduit elbow **OR** cable entry port, **as directed**, at base.
 - 4. Water Absorption: Not more than 3 percent.
 - 5. Surface: Smooth, hard, nonporous, and resistant to soil acids **OR** road salts **OR** frost and freezing damage, **as directed**.
 - 6. Pole Marking:
 - a. Manufacturer's Mark: Comply with ATIS O5.1; locate 10 feet (3 m) from the pole butt for poles 50 feet (15 m) long or less.
 - b. Pole Number: Machine-embossed aluminum, alphanumeric characters not less than 2-1/2 inches (65 mm) high.
- D. Crossarms
- 1. Description: Solid-wood distribution type, complying with RUS Bulletin 1728H-701 for specified construction grade **OR** Galvanized, steel angles, **as directed**, and complying with IEEE C2 for required climbing space and wire clearances.
 - 2. Braces: Galvanized, flat, ferrous-metal units; 1/4 inch (6 mm) thick by 1-1/4 inches (30 mm) wide, minimum, with length to suit crossarm dimensions.
- E. Guys And Anchors
- 1. Guy Strand Assemblies: Cable and attachment assemblies shall have uniform minimum breaking strength of the cable.
 - 2. Cable: Seven strands. Zinc-coated steel, complying with ASTM A 475 **OR** Aluminum-clad steel, complying with ASTM B 416 **OR** Copper-clad steel, complying with ASTM B 228, **as directed**. Breaking strength shall be not less than 10,000 lb (45 kN).
 - 3. Cable Termination:
 - 1) Thimble eye.

OR

- Hooks and guy strain plates, complying with IEEE C135.1.
 - 2) Preformed galvanized-steel guy grips, matching material, galvanizing, and strength of the guy strand assembly.
 4. Anchor and Anchor-Rod Assemblies: Hot-dip galvanized steel.
 - a. Power-installed screw-type anchors.
 - 1) 15-inch (380-mm) screw; with rod 96 inches (2400 mm) long by 1-1/2 inches (38 mm) in diameter. Rated at 10,000 lb (45 kN) when installed.
 - 2) Guy anchors shall have strength and holding area as required for anchor load and soil conditions at location of that anchor.
 5. Strain Insulators: Epoxy-bonded fiberglass of length to meet clearance requirements specified in "Guy Installation" Article.
 6. Guy Markers: Round, of vinyl or PVC material, white **OR** yellow, **as directed**, color, 96 inches (2440 mm) long. Shatter resistant at temperatures below 0 deg F (minus 18 deg C).
- F. Hardware And Accessories
1. Description: Ferrous-metal items include, but are not limited to, bolts, nuts, washers, crossarm gains and braces, insulator pins, anchor rods, anchors, eyebolts, staples, and transformer brackets.
 - a. Comply with IEEE C135.1, IEEE C135.2, ANSI C135.4, ANSI C135.22, and RUS Informational Publication 202-1 listings with the exception that base material shall be malleable iron or ductile iron, and finish shall be hot-dip galvanized, **as directed**.
 2. Insulator Brackets: Hot-dip galvanized steel, style as indicated, designed to hold vertical-post-type or pin-type insulators, with one **OR** two, **as directed**, -bolt attachment to pole.
 3. Secondary Insulator Racks: Hot-dip galvanized steel, style as indicated, with smooth, rounded 12-gage struts designed to support two **OR** three **OR** four, **as directed**, spool insulators for attachment of secondary drop conductors. Spool spacing of 4 inches (100 mm) **OR** 8 inches (200 mm) **OR** 12 inches (300 mm), **as directed**.
 4. Pole Riser Shields: Galvanized steel with boot **OR** backplate **OR** vent, **as directed**.
 5. Padlocks: ASTM F 883.
 - a. Class: PO1 **OR** PO2, **as directed**.
 - b. Grade: 1 **OR** 2 **OR** 3 **OR** 4 **OR** 5 **OR** 6, **as directed**.
 - c. Option: A **OR** B **OR** C **OR** D **OR** E **OR** F **OR** G, **as directed**.
 6. Insulators: Units rated 6 kV and above shall be free from radio interference.
 - a. Porcelain insulators shall be wet-process type, complying with the following:
 - 1) Pin: ANSI C29.5.
 - 2) Line Post: ANSI C29.7. Include mounting stud of length suitable for each mounting arrangement used.
 - 3) Suspension: ANSI C29.2.
 - 4) Guy Strain: ANSI C29.4.
 - 5) Secondary Spool: ANSI C29.3, Class 53-2.
 - b. Polymer-composite, fiberglass-reinforced insulators shall comply with the following:
 - 1) Line Post: CEA LWIWG-02.
 - 2) Dead End/Suspension: CEA LWIWG-01.
 - 3) Guy Strain: Fiberglass reinforced, epoxy finished. Designed specifically for use in guy assemblies.
 7. Grounding Materials: Comply with Division 26 Section "Grounding And Bonding For Electrical Systems", using materials listed by RUS for the intended purpose without restriction.
 - a. Conductors: No. 4 AWG, minimum; bare, solid, annealed copper, complying with ASTM B 8 unless otherwise indicated.
 - b. Ground Conductor Protectors: PVC or half-round wood molding, fir, pressure treated according to AWPAC 25 **OR** cypress **OR** cedar, **as directed**.
- G. Surge Arresters
1. Distribution-Class Surge Arresters: Porcelain **OR** Polymer, **as directed**, -enclosed, gapless, metal-oxide type with automatic-indicating type, ground-lead disconnection feature, **as directed**, complying with IEEE C62.11 and NEMA LA 1.

2. Intermediate-Class Surge Arresters: Porcelain **OR** Polymer, **as directed**, -enclosed, gapless, metal-oxide type, complying with IEEE C62.11 and NEMA LA 1.
 - a. Voltage Rating: 3 **OR** 6 **OR** 9 **OR** 10 **OR** 12 **OR** 15 **OR** 27 **OR** 30 **OR** 36, **as directed**, kV, at the altitude of Project, unless otherwise indicated.

H. Cutouts, Switches, And Fuses

1. Description: Medium-voltage disconnect, protective, and bypass, **as directed**, units shall be rated for the line-to-line voltage of the systems in which installed, unless higher ratings are indicated. BIL ratings are 45 **OR** 60 **OR** 75 **OR** 95 **OR** 150 **OR** 200, **as directed**, kV.
 - a. Momentary Current Rating of Switching Devices: 20 **OR** 40, **as directed**, kA, asymmetrical at nominal system operating voltage.
 - b. Fuse Characteristics: Time-current characteristics for each set of fuses selected according to written recommendations of manufacturer of component protected by the fuses and coordinated with upstream and downstream protective devices. Prepare time-current coordination curves according to IEEE 242 that illustrate optimum coordination of devices in this Project.
 - c. Interrupting Rating of Fuses: **<Insert value>** symmetrical A at nominal system operating voltage.
2. Fuse Cutouts: Open **OR** enclosed, **as directed**, type, rated 100 **OR** 200, **as directed**, A, continuous, complying with ANSI C37.42.
 - a. Fuses: Enclosed link, Type K **OR** Type T, **as directed**, complying with ANSI C37.42.
 - b. Fuse Current Rating: 150 percent of the transformer full-load current unless otherwise indicated.
 - c. Switching Application: Include switch link instead of fuse.
 - d. Switch Current Interrupting Rating: Transformer magnetizing current.
3. Fused Switches: Single-pole, manual units.
 - a. Switch Rating: 400 **OR** 600, **as directed**, -A rms continuous and load-current interrupting.
 - b. Fuses: Dropout-type power fuses.
4. Nonfused Switches: Single-pole, manual units, rated 100 **OR** 200 **OR** 400 **OR** 600, **as directed**, -A rms continuous.
5. Group-Operated, Load-Interrupter Switches: Fused **OR** Nonfused, **as directed**, three-pole, single-throw units, manually operated by handle through insulated mechanical linkage.
 - a. High-pressure contact type, complying with ANSI C37.32.
 - b. Factory assembled to suit specific configuration and mounting conditions for this Project.
 - c. Operating Handle: Padlock equipped.
 - d. Current Interrupting Rating: Equal to continuous current rating of switch.
 - e. Fuses: Nondropout power type.
6. Group-Operated, Air-Break (Nonloadbreak) Switches: Three-pole, single-throw units, manually operated by handle through insulated mechanical linkage.
 - a. Comply with ANSI C37.32.
 - b. Factory assembled to suit specific configuration and mounting conditions for this Project.
 - c. Operating Handle: Padlock equipped.
 - d. Suitable for field conversion to load-interrupter switch by adding interrupter modules.

I. Distribution Transformers

1. Description: Single-phase, two-winding, single **OR** two, **as directed**, -bushing, liquid-filled, self-cooled, pole-mounting distribution type, suitable for external fuse and surge suppressor protection; complying with IEEE C 57.12.00, and tested according to IEEE C 57.12.90 and with the following additional requirements, **as directed**:
 - a. Cooling Class: OA.
 - b. Temperature Rise: 65 deg C.
 - c. Insulating Liquid: Mineral oil, ASTM D 3487, Type II.

OR

Insulating Liquid: High molecular weight, mineral oil based, and UL listed as less-flammable type.

OR

Insulating Liquid: Biodegradable insulating and cooling liquid, UL listed as less flammable type.

- d. Identification: Label the transformer as "non-PCB" and place manufacturer's name and type of fluid on the nameplate.
2. BIL: 95 **OR** 75 **OR** 60, **as directed**, kV.
3. Taps: Two, 2.5 percent above and below **OR** Four, 2.5 percent below, **as directed**, high-voltage and full-load rated. Tap changer shall have an external operating handle, **as directed**.
4. Mounting Brackets: Single **OR** Double, **as directed**, integral; suitable for pole mounting, individually or in cluster, or on crossarm.
5. Minimum Efficiency: Class 1, as defined by NEMA TP 1, based on test results that comply with requirements of NEMA TP 2.
6. Bushings: Creepage distance shall exceed nominal value standard for unit rating by at least 75 percent.
7. Hardware: Stainless steel.
8. Tank and Cover: Stainless steel, complying with ASTM A 167, Type 304 or 304L, with paint coating exterior finish system complying with IEEE C57.12.28, including manufacturer's standard color finish coat.
9. Show transformer kiloampere capacity using 2-1/2-inch (65-mm) numerals placed near the low-voltage bushings.

J. Primary Metering Equipment

1. Metering Transformers: Outdoor current and potential transformers, designed for crossarm mounting, complying with IEEE C57.13, and having the following features:
 - a. BIL: 45 **OR** 60 **OR** 75 **OR** 95 **OR** 150 **OR** 200, **as directed**, kV.
 - b. Secondary connection box arranged for conduit connection.
 - c. Potential-Transformer Voltage Rating: 2.4 **OR** 4.16 **OR** 7.2 **OR** 12.0 **OR** 12.47, **as directed**, kV to 120-V ac, 60 Hz.
 - d. Potential-Transformer Accuracy Class: Minimum 0.3 at 75-VA burden.
 - e. Voltage Rating: 2.4 **OR** 4.16 **OR** 7.2 **OR** 12.0 **OR** 12.47, **as directed**, kV.
 - f. Current Rating: <Insert value> to 5 A.
 - g. Accuracy Class: Minimum 0.2 at 50-VA burden.
2. Watt-Hour Meter: Outdoor solid-state unit, with demand register, **OR** arranged for pulse initiation, **as directed**, complying with ANSI C12.10, and including the following ratings and features:
 - a. Form: 8S **OR** 9S, **as directed**.
 - b. Element: 2 **OR** 2-1/2 **OR** 3, **as directed**.
 - c. Voltage: 120 V.
 - d. Current: 2-1/2 A.
 - e. Frequency: 60 Hz.
 - f. Kilowatt-Hour Register: Five-digit type.
 - g. Demand-Register Multiplier: A quantity in even hundreds, indicated on meter face.
 - h. Demand-Register Interval: 15 **OR** 30, **as directed**, minutes.
 - i. Mounting: On matching socket, complying with ANSI C12.7, and complete with automatic current short-circuiting device.
 - j. Meter Test Block: Matched to meter, and furnished and equipped with open knife switches designed to isolate each metering component for test.
 - k. Meter Cabinet: Galvanized steel; weatherproof enclosure with pole-mounting bracket and the following features:
 - 1) Hinged Door: Arranged for padlocking in closed position.
 - 2) Size: Adequate to house meter and other equipment indicated, but not less than 20 by 30 by 11 inches (510 by 760 by 280 mm) deep.

K. Source Quality Control

1. Factory Tests: Conduct routine tests of transformers **OR** medium-voltage switches **OR** metering equipment, **as directed**, according to referenced standards.

2. Testing Agency: Engage a qualified testing agency to inspect poles and crossarms before and after preservative treatment for compliance of wood poles and crossarms with requirements indicated. RUS quality mark "WQC" on each item is acceptable in place of inspection as evidence of compliance.
3. Poles and crossarms will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

1.3 EXECUTION

A. Right-Of-Way Clearance And Tree Trimming

1. Clear right of way according to Division 01 Section(s) "Temporary Tree And Plant Protection" AND Division 31 Section(s) "Site Clearing".
2. Clear right of way to maintain minimum clearances required by IEEE C2, unless Drawings indicate greater clearances or greater clearances are required by state or local codes or regulations. If no minimum requirements are mandated, maintain a minimum of **15 feet (4.5 m)** on both sides horizontally and below medium-voltage conductors and **60 inches (1500 mm)** on both sides horizontally and below secondary-voltage conductors. Remove overhanging branches.

B. General Installation Requirements

1. Install underground power and metering circuits and those circuits indicated to be in raceways according to Division 26 Section "Underground Ducts And Raceways For Electrical Systems" and Division 26 Section "Medium-voltage Cables", and make splices and terminations for those circuits according to the applicable Sections.
2. Engage the services of a licensed surveyor to verify dimensions by field measurement, to identify locations of poles, anchors, and other features, and to verify all clearances. The survey document shall also identify locations of connections to new and existing supply lines and to primary and secondary services. Notify the Owner of discrepancies and field conditions that are not indicated and that will affect installation.
3. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
4. Apply warning signs and equipment labels according to Division 26 Section "Identification For Electrical Systems".

C. Conductor Installation, General

1. Handle and string conductors to prevent cuts, gouges, scratches, kinks, flattening, or deformation. Remove damaged sections and splice conductors.
 - a. String new conductors to "initial" sag values recommended by manufacturer for type and size of conductor except as otherwise indicated.
 - b. Conductors Reinstalled or Resagged: String to "final" sag values recommended by manufacturer for type and size of conductor except as otherwise indicated.
2. Connections, Splices, and Terminations: Use kits listed for the specific type of connection and combination of materials in the connection or recommended for the specific use by manufacturer of material on which applied.
 - a. Splice Location: Do not install within **10 feet (3 m)** of a support.
 - b. Line Conductors and Service Drops: Install so strength exceeds ultimate rated strength of conductor.
 - c. Splices and Terminations of Covered Conductors: Comply with manufacturer's written instructions.
 - d. Splices and Terminations of Insulated Conductors of Self-Supported, Medium-Voltage Cable: Comply with manufacturer's written instructions.

D. Medium-Voltage Line Conductor Installation

1. Application: Install bare conductors unless otherwise indicated.

2. Armor Rod: Install to protect conductors if line conductors are supported by insulators.
 3. Flat Aluminum Armor Wire: Install to protect conductors if they are supported by, or attached to, galvanized or coated iron or steel clamps or fittings.
 4. Support line conductors and taps as follows:
 - a. Use wire ties for conductor attachment to pin and vertical post insulators unless otherwise indicated.
 - b. Install wire ties tight against conductor and insulator, and turn ends back and flat against conductor, to eliminate exposed wire ends.
 - c. Use wire clamps on horizontal post, dead end, and suspension insulators unless otherwise indicated.
- E. Pole And Crossarm Installation
1. Pole Orientation: Align curve of curved wood poles with straight-line runs of three or more poles. Align gained surfaces perpendicular to runs.
 2. Elevation of Line above Grade: Install poles with top at same elevation, unless grade changes dictate elevation change in poles, and according to the following:
 - a. On level ground, set poles so tops of consecutive poles vary not more than **60 inches (1500 mm)** in elevation.
 - b. Shorten wood poles by cutting off the top and make cuts to shed water. Apply preservative to cuts.
 3. Set poles according to the following:
 - a. Make pole holes vertical, uniform in diameter, and large enough to permit effective use of tamping bars all around. Bore or excavate holes with an average diameter at grade less than twice the diameter of the pole at the same grade.
 - b. Use minimum depths indicated, except at locations where hole is partly or entirely in rock and if hole is not vertical or has a diameter at grade more than two times the pole diameter at the same level; in these conditions, increase the depth of the hole by the following increments before setting the pole:
 - 1) Poles up to **35 Feet (10.6 m)** Long: **24 inches (600 mm)**.
 - 2) Poles **36 to 60 Feet (11 to 18.3 m)** Long: **30 inches (760 mm)**.
 - 3) Poles **61 to 75 Feet (18.6 to 22.9 m)** Long: **36 inches (900 mm)**.
 - c. For poles on slopes, indicated hole depth is from finished grade at lowest side of hole.
 - d. Set poles in alignment and plumb except at dead ends, angles, and points of extra strain; rake poles against conductor strain **1 inch (25 mm)** minimum, **2 inches (51 mm)** maximum, (after conductors are installed at required tension) for each **10 feet (3 m)** of pole length. Rake poles so they will not lean or bend in direction of strain when loaded.
 - e. Backfill holes in **6-inch (150-mm)** maximum lifts, and thoroughly tamp each layer before starting the next.
 - f. Place surplus earth around pole in a conical shape, and tamp thoroughly to provide drainage away from pole.
 - g. Set poles so alternate crossarm gains face in alternate directions, except at terminals and dead ends; place gains on last two poles on side facing terminal or dead end.
 - h. Poles Set in Concrete Paved Areas: Install poles with minimum of **6-inch- (150-mm-)** wide, unpaved gap between the pole 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.
 4. Field treat factory-treated poles and crossarms as follows:
 - a. Poles Treated More Than One Year before Installation: Treat portion from **24 inches (600 mm)** above ground line to butt.
 - b. Field-Bored Holes and Field-Cut Gains and Pole Tops: Treat cut portions.
 - c. Unused Holes: Treat and plug with treated-wood-dowel drive pins.
 - d. Engage the services of a technician certified according to "Quality Assurance" Article to apply treatment. Comply with requirements in AWPAs standards that govern original factory treatment for field-applied treatment and application of chemicals.
 5. Crossarm Installation: Set line crossarms at right angle to line for straight runs and for angles 45 degrees and more. Bisect angles less than 45 degrees.
 - a. Buck Arms: Install at corners and junction poles unless otherwise indicated.

- b. Double Crossarms: Install at dead ends, corners, angles, and line crossings.
 - c. Equipment Arms: Locate below lines and set parallel or at right angles to them, whichever provides best climbing space.
 - d. Gains: Install factory-cut or metal-pole gains only. Do not cut gains in field without specific written approval.
6. Locate pole numbers to provide maximum visibility from the road or patrol route.

F. Guy Installation

- 1. Install guys to resist unbalanced loads, including those developed at angles, corners, and dead ends. Install two or more guys if a single guy will not provide adequate strength. Install separate guys if unbalanced loads are separated by **36 inches (900 mm)** or more. Comply with IEEE C2.
 - a. Unless a thimble eye is used, at the pole end, install a minimum of two guy hooks and two guy strain plates.
 - b. At the anchor end, attach guy strand assembly with preformed grips.
- 2. Protect guy strands from damage. Replace damaged guy strands. Install guy insulators where required to comply with IEEE C2 clearance requirements.
- 3. Install guys with a lead-to-height ratio of 1 to 1 unless otherwise indicated. The minimum lead-to-height ratio shall be 1/2 to 1. When less than 1 to 1, increase guy strength by the ratio of the sine of the lead angle indicated to the sine of the lead angle provided.
- 4. Install screw-type guy anchors aligned in soil with guy. Set with anchor rod pointing at guy attachment on pole and rod projecting **6 to 9 inches (150 to 230 mm)** from ground.
- 5. Install strain insulators to provide a minimum of **12 inches (300 mm)** of clearance between the nearest energized surface and the strain insulator fitting farthest from the pole. When loaded to the tension indicated, fiberglass strain insulators shall be loaded to not more than two-thirds of manufacturer's published rating.
- 6. Guy Markers: Install at anchor end of guys to visually mark the guy wire at all accessible locations. Clamp to guy strand or anchor at top and bottom of marker.

G. Hardware And Accessories Installation

- 1. Install washers against wood and under nuts, including eyenuts and locknuts.
- 2. Install nuts and locknuts wrench-tight on threaded connections.

H. Insulator Installation

- 1. Medium-Voltage Line Application: Install pin **OR** post, **as directed**, type, except install suspension type at corners, angles, dead ends, and other locations where horizontal forces exceed rated values for pin or line-post-type units.
 - a. Install suspension insulators and hardware that have mechanical strength exceeding rated breaking strength of attached conductors.
 - b. Install horizontal line-post insulators for armless construction.
- 2. Post-Insulator Conductor Support: Where installed horizontally and for line angles more than 15 degrees, install clamp-top conductor clamps.
- 3. Install spool-type insulators for secondary lines mounted on clevis attachments or secondary racks.
- 4. Guy Strain Type: Install porcelain **OR** fiberglass-reinforced, **as directed**, units.

I. Surge Arresters

- 1. Install surge arresters to protect distribution **OR** metering equipment **OR** reclosers, **as directed**, group-operated, load-interrupter switches, **as directed**, aerial-to-underground transitions, **as directed**, and other items indicated.
 - a. Units Installed **6000 Feet (1800 m)** or More above Sea Level: Use arresters specifically rated for this service.

J. Cutout, Switch, And Fuse Installation

- 1. Hook-Stick-Operated Switches: Install to maximize safe operating access.

2. Group-Operated, Load-Interrupter Switches and Air-Break Switches: Install operating handle **42 inches (1067 mm)** above finished grade.
 - a. Locking Provisions: Install padlock at hasp.
- K. Metering Component Installation
 1. Current and Voltage Transformers: Install secondary conductors between transformers and cabinet in sleeves made of galvanized rigid steel **OR** intermediate metal **OR** PVC, **as directed**, conduit. Install to prevent collection of moisture in raceway and cabinet system.
 2. Meter Cabinet: Mount on pole, **72 inches (1825 mm)** above finished grade to center of cabinet.
 - a. Make conduit connections with raintight hubs.
 - b. Install metering transformer secondary leads without splices. Train leads at sides and bottom of enclosure, and secure with wire ties.
 - c. Install meter and meter test block within cabinet.
 - d. Install identical phase sequence, and color-code for both potential and current leads.
 - e. Identify leads using designations consistent with marking on transformer terminals.
- L. Field Quality Control
 1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
 2. Perform tests and inspections.
 3. Tests and Inspections:
 - a. Furnish instruments and equipment required for tests that comply with NETA Acceptance Testing Specification.
 - b. Guy Anchors: Test one of each type and capacity installed, plus additional units specifically indicated for testing, **as directed**. Apply rated pull-out force in the same pull direction applied by the guy at the test location.
 - 1) Acceptable Test Results: Denoted by movement of less than **3/8 inch (10 mm)** by the holding component of the anchor in the earth or other medium in which it is installed.
 - 2) Replace or reinstall, at the Owner 's option, all anchors of same type and capacity as anchor type that fails this test.
 - c. Ground Resistance: Comply with Division 26 Section "Grounding And Bonding For Electrical Systems". Measure resistance of each separate grounding electrode, including pole grounds. Also measure resistance of separate grounding electrode systems before bonding together.
 - 1) Perform tests and obtain acceptable results before energizing any portion of overhead electrical distribution system.
 - 2) Results and Follow-up: If ground resistance for a single ground electrode or pole ground, tested individually, exceeds 25 ohms, add a ground electrode not less than **10 feet (3 m)** away and interconnect with No. 2 AWG, minimum, bare conductor buried at least **12 inches (300 mm)** below furnished grade.
 - d. Aerial Conductor Sag and Tension: Observe procedures used by Contractor to verify that initial stringing sags and tensions comply with IEEE C2 and conductor manufacturer's product data and written recommendations.
 - e. Self-Supported, Medium-Voltage Cable: After installation, while cable is isolated, and after terminations are installed and before connecting or energizing, apply dc voltage between each phase conductor and grounding connections of sheath or metallic shield. Comply with NEMA WC 70/ICEA S-95-658 for method, voltage, duration, pass-fail performance, and other test criteria. Perform other field inspections and tests recommended by manufacturer.
 - f. Neutral-Supported, Secondary Service-Drop Cable: Test for insulation resistance while cable is isolated, before connecting or energizing. Minimum acceptable resistance is 100 megohms.
 - g. Existing Surge Arresters: Disconnect and measure resistance between line and ground terminals with a megger test rated 600 V or more. Acceptable resistance values are 300 megohms and more.

- h. New Surge Arresters, Cutouts, and Switches: Inspect after installation and connection to wiring. Verify that ratings and characteristics match approved submittals and comply with system requirements. Verify that installation complies with requirements and that clearances of units and connecting wiring comply with IEEE C2 requirements.
 - 1) Verify proper grounding of metallic equipment parts.
 - 2) Fuses and Disconnect Links: Verify that ratings and characteristics match submittals and comply with system requirements.
 - 3) Switches:
 - a) Manually operate each cutout and switch at least three times, to verify proper operation.
 - b) Verify correct contact alignment, blade penetration, travel stops, and arc interrupter operation.
 - 4) Group-Operated, Load-Interrupter Switches and Air-Break Switches:
 - a) Perform mechanical operator tests according to manufacturer's written instructions.
 - b) Test resistance to ground of parts to be energized. Acceptable value is 200,000 megohms.
 - c) Perform contact-resistance test across all switch blade contacts. Refer to manufacturer's data for acceptable contact resistance.
 - 5) Verify that clearances of energized parts and connecting wires comply with IEEE C2 requirements.
 - i. Distribution Transformers: Inspect after installation and connection to wiring and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.
 - 1) Inspect for physical damage, cracked insulators, leaks, tightness of connections, and overall mechanical and electrical integrity.
 - 2) Perform preenergizing inspections and tests recommended by manufacturer.
 - 3) Verify proper equipment grounding.
 - 4) Verify that clearances of terminals and connecting wires comply with IEEE C2.
 - j. Metering Transformers: Inspect after installation and connection to wires, and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.
 - 1) Verify proper connections, tightness of bolted connections, and integrity of mounting provisions.
 - 2) Verify that required grounding and shorting connections provide good contact.
 - 3) Verify that clearances of terminals and connecting wires comply with IEEE C2.
 - 4) Perform electrical tests according to manufacturer's written instructions, including insulation-resistance tests, polarity tests, and turns-ratio and ratio-verification tests.
 - k. Meters: Inspect after installation and connection to wiring and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.
 - 1) Verify tightness of electrical connections.
 - 2) Verify accuracy at 25, 50, 75, and 100 percent of full-rated load and verify all instrument multipliers according to manufacturer's written instructions.
4. Prepare test and inspection reports.
- M. Adjusting
1. Distribution Transformers: Set voltage taps as directed by the Owner.
- N. Cleaning
1. After completing equipment installation, inspect equipment. Remove spots, dirt, and debris. Repair damaged finish to match original finish. For distribution transformer, use tank touchup paint provided by manufacturer.
 - a. Clean enclosures internally, on completion of installation, according to manufacturer's written instructions.

-
- O. Demonstration
 - 1. Train Owner's maintenance personnel to adjust, operate, and maintain overhead electrical distribution.

END OF SECTION 26 05 26 00b

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SECTION 26 05 29 00 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for hangers and supports 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. Hangers and supports for electrical equipment and systems.
 - b. Construction requirements for concrete bases.

C. Definitions

1. EMT: Electrical metallic tubing.
2. IMC: Intermediate metal conduit.
3. RMC: Rigid metal conduit.

D. Performance Requirements

1. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
3. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
4. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

E. Submittals

1. Product Data: For the following:
 - a. Steel slotted support systems.
 - b. Nonmetallic slotted support systems.
2. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - a. Trapeze hangers. Include Product Data for components.
 - b. Steel slotted channel systems. Include Product Data for components.
 - c. Nonmetallic slotted channel systems. Include Product Data for components.
 - d. Equipment supports.
3. Welding certificates.

F. Quality Assurance

1. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. Comply with NFPA 70.

1.2 PRODUCTS

A. Support, Anchorage, And Attachment Components

1. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - a. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - b. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - c. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - d. Channel Dimensions: Selected for applicable load criteria.
 2. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with **9/16-inch- (14-mm-)** diameter holes at a maximum of **8 inches (200 mm)** o.c., in at least 1 surface.
 - a. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 - b. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
 - c. Rated Strength: Selected to suit applicable load criteria.
 3. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
 4. Conduit and Cable Support Devices: Steel **OR** Steel and malleable-iron, **as directed**, hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
 5. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
 6. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 7. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - a. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - b. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel **OR** stainless steel, **as directed**, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - c. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - d. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - e. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - f. Toggle Bolts: All-steel springhead type.
 - g. Hanger Rods: Threaded steel.
- B. Fabricated Metal Equipment Support Assemblies
1. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
 2. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

1.3 EXECUTION

A. Application

1. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
2. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by **OR** scheduled in NECA 1, where its Table 1 lists maximum

- spacings less than stated in, **as directed**, NFPA 70. Minimum rod size shall be **1/4 inch (6 mm)** in diameter.
3. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - a. Secure raceways and cables to these supports with two-bolt conduit clamps **OR** single-bolt conduit clamps **OR** single-bolt conduit clamps using spring friction action for retention in support channel, **as directed**.
 4. Spring-steel clamps designed for supporting single conduits without bolts may be used for **1-1/2-inch (38-mm)** and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
- B. Support Installation
1. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
 2. Raceway Support Methods: In addition to methods described in NECA 1, EMT **OR** IMC **OR** RMC, **as directed**, may be supported by openings through structure members, as permitted in NFPA 70.
 3. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus **200 lb (90 kg)**.
 4. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - a. To Wood: Fasten with lag screws or through bolts.
 - b. To New Concrete: Bolt to concrete inserts.
 - c. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - d. To Existing Concrete: Expansion anchor fasteners.
 - e. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete **4 inches (100 mm)** thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than **4 inches (100 mm)** thick.
 - f. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts **OR** Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 **OR** Spring-tension clamps, **as directed**.
 - g. To Light Steel: Sheet metal screws.
 - h. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
 5. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
- C. Installation Of Fabricated Metal Supports
1. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
 2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
 3. Field Welding: Comply with AWS D1.1/D1.1M.
- D. Concrete Bases
1. Construct concrete bases of dimensions indicated but not less than **4 inches (100 mm)** larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

2. Use **3000-psi (20.7-MPa)**, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-place Concrete".
3. Anchor equipment to concrete base.
 - a. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - b. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - c. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

E. Painting

1. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - a. Apply paint by brush or spray to provide minimum dry film thickness of **2.0 mils (0.05 mm)**.
2. Touchup: Comply with requirements in Division 07 OR Division 09 Section(s) "High-performance Coatings" **as directed**, for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
3. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29 00

SECTION 26 05 29 00a - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for vibration and seismic controls 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. Isolation pads.
 - b. Spring isolators.
 - c. Restrained spring isolators.
 - d. Channel support systems.
 - e. Restraint cables.
 - f. Hanger rod stiffeners.
 - g. Anchorage bushings and washers.

C. Definitions

1. The IBC: International Building Code.
2. ICC-ES: ICC-Evaluation Service.
3. OSHPD: Office of Statewide Health Planning and Development for the State of California.

D. Performance Requirements

1. Seismic-Restraint Loading:
 - a. Site Class as Defined in the IBC: **A OR B OR C OR D OR E OR F, as directed.**
 - b. Assigned Seismic Use Group or Building Category as Defined in the IBC: **I OR II OR III, as directed.**
 - 1) Component Importance Factor: **1.0 OR 1.5, as directed.**
 - 2) Component Response Modification Factor: **1.5 OR 2.5 OR 3.5 OR 5.0, as directed.**
 - 3) Component Amplification Factor: **1.0 OR 2.5, as directed.**
 - c. Design Spectral Response Acceleration at Short Periods (0.2 Second): As required to meet Project requirements.
 - d. Design Spectral Response Acceleration at 1.0-Second Period: As required to meet Project requirements.

E. Submittals

1. Product Data: For the following:
 - a. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - b. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - 1) Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed.**
 - 2) Annotate to indicate application of each product submitted and compliance with requirements.
 - c. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.
2. Delegated-Design Submittal: For vibration isolation and seismic-restraint details 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 static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
 - 1) Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 for equipment mounted outdoors.
- b. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
- c. Field-fabricated supports.
- d. Seismic-Restraint Details:
 - 1) Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - 2) Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - 3) Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed**, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- 3. Welding certificates.
- 4. Field quality-control test reports.

F. Quality Assurance

- 1. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- 2. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- 3. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- 4. Comply with NFPA 70.

1.2 PRODUCTS

A. Vibration Isolators

- 1. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - a. Resilient Material: Oil- and water-resistant neoprene **OR** rubber **OR** hermetically sealed compressed fiberglass, **as directed**.
- 2. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 - a. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - b. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - c. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - d. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

- e. Baseplates: Factory drilled for bolting to structure and bonded to **1/4-inch- (6-mm-)** thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to **500 psig (3447 kPa)**.
 - f. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
3. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
 - a. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to **1/4-inch- (6-mm-)** thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 - b. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
 - c. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - d. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - e. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - f. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- B. Seismic-Restraint Devices
1. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed**.
 - a. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
 2. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
 3. Restraint Cables: ASTM A 603 galvanized-steel **OR** ASTM A 492 stainless-steel, **as directed**, cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
 4. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections **OR** Reinforcing steel angle clamped, **as directed**, to hanger rod. Do not weld stiffeners to rods.
 5. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.
 6. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.
 7. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
 8. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
 9. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.
- C. Factory Finishes

1. Finish:
 - a. Manufacturer's standard prime-coat finish ready for field painting.
 - b. Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1) Powder coating on springs and housings.
 - 2) All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 - 3) Baked enamel or powder coat for metal components on isolators for interior use.
 - 4) Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

1.3 EXECUTION

A. Applications

1. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed**.
2. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
3. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

B. Seismic-Restraint Device Installation

1. Equipment and Hanger Restraints:
 - a. Install restrained isolators on electrical equipment.
 - b. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds **0.125 inch (3.2 mm)**.
 - c. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES **OR** OSHPD **OR** an agency acceptable to authorities having jurisdiction, **as directed**, providing required submittals for component.
2. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
3. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
4. Drilled-in Anchors:
 - a. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - b. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - c. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - d. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - e. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - f. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

- C. Accommodation Of Differential Seismic Motion
 - 1. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.
- D. Field Quality Control
 - 1. Tests and Inspections:
 - a. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - b. Schedule test with the Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - c. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - d. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 - e. Test to 90 percent of rated proof load of device.
 - f. Measure isolator restraint clearance.
 - g. Measure isolator deflection.
 - h. Verify snubber minimum clearances.
 - i. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
 - 2. Remove and replace malfunctioning units and retest as specified above.
 - 3. Prepare test and inspection reports.
- E. Adjusting
 - 1. Adjust isolators after isolated equipment is at operating weight.
 - 2. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
 - 3. Adjust active height of spring isolators.
 - 4. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 26 05 29 00a

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Task	Specification	Specification Description
26 05 29 00	01 22 16 00	No Specification Required
26 05 29 00	05 12 23 00	Cold-Formed Metal Framing
26 05 29 00	05 50 00 00	Metal Fabrications
26 05 33 13	26 05 00 00	Common Work Results for Electrical
26 05 33 13	26 05 19 16	Common Work Results for Communications
26 05 33 13	26 05 19 16a	Common Work Results for Electronic Safety and Security
26 05 33 13	26 05 19 16b	Electrical Renovation
26 05 33 13	26 05 19 16c	Conductors And Cables
26 05 33 13	26 05 19 16f	Communications Equipment Room Fittings
26 05 33 13	26 05 19 16g	Communications Backbone Cabling
26 05 33 13	26 05 19 16h	Communications Horizontal Cabling
26 05 33 13	26 05 19 16i	Conductors and Cables for Electronic Safety and Security

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SECTION 26 05 33 16 - 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): LPMC **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 LPMC 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.

END OF SECTION 26 05 33 16

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SECTION 26 05 33 16a - WIRING DEVICES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of wiring devices. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Receptacles, receptacles with integral GFCI, and associated device plates.
 - b. Twist-locking receptacles.
 - c. Receptacles with integral surge suppression units.
 - d. Wall-box motion sensors.
 - e. Isolated-ground receptacles.
 - f. Hospital-grade receptacles.
 - g. Snap switches and wall-box dimmers.
 - h. Solid-state fan speed controls.
 - i. Wall-switch and exterior occupancy sensors.
 - j. Communications outlets.
 - k. Pendant cord-connector devices.
 - l. Cord and plug sets.
 - m. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

C. Definitions

1. EMI: Electromagnetic interference.
2. GFCI: Ground-fault circuit interrupter.
3. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
4. RFI: Radio-frequency interference.
5. TVSS: Transient voltage surge suppressor.
6. UTP: Unshielded twisted pair.

D. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
3. Samples: One for each type of device and wall plate specified, in each color specified.
4. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

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. Straight Blade Receptacles

1. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

2. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498 Supplement SD.
 3. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - a. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
 4. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - a. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.
- B. GFCI Receptacles
1. General Description: Straight blade, feed **OR** non-feed, **as directed**,-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
 2. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
 3. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with UL 498 Supplement SD.
- C. TVSS Receptacles
1. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 1449, with integral TVSS in line to ground, line to neutral, and neutral to ground.
 - a. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
 - b. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
 2. Duplex TVSS Convenience Receptacles:
 - a. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R.
 3. Isolated-Ground, Duplex Convenience Receptacles:
 - a. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
 4. Hospital-Grade, Duplex Convenience Receptacles: Comply with UL 498 Supplement SD.
 - a. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R.
 5. Isolated-Ground, Hospital-Grade, Duplex Convenience Receptacles:
 - a. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R. Comply with UL 498 Supplement SD. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
- D. Hazardous (Classified) Location Receptacles
1. Available Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.
- E. Twist-Locking Receptacles
1. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.
 2. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:
 - a. Description: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. Equipment grounding contacts shall be connected only to the green grounding screw

terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

F. Pendant Cord-Connector Devices

1. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.
 - a. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
 - b. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

G. Cord And Plug Sets

1. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - a. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 - b. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

H. Snap Switches

1. Comply with NEMA WD 1 and UL 20.
2. Switches, 120/277 V, 20 A:
3. Pilot Light Switches, 20 A:
 - a. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."
4. Key-Operated Switches, 120/277 V, 20 A:
 - a. Description: Single pole, with factory-supplied key in lieu of switch handle.
5. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
6. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

I. Wall-Box Dimmers

1. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
2. Control: Continuously adjustable slider **OR** toggle switch **OR** rotary knob, **as directed**; with single-pole or three-way switching. Comply with UL 1472.
3. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
 - a. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "OFF," **as directed**.
4. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

J. Fan Speed Controls

1. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.
 - a. Continuously adjustable slider **OR** toggle switch **OR** rotary knob, **as directed**, 5 A **OR** 1.5 A, **as directed**.
 - b. Three-speed adjustable slider **OR** rotary knob, **as directed**, 1.5 A.

K. Occupancy Sensors

1. Wall-Switch Sensors:

- a. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of **900 sq. ft. (84 sq. m).**
 2. Wall-Switch Sensors:
 - a. Description: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of **900 sq. ft. (84 sq. m).**
 3. Long-Range Wall-Switch Sensors:
 - a. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, with a minimum coverage area of **1200 sq. ft. (111 sq. m).**
 4. Long-Range Wall-Switch Sensors:
 - a. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of **1200 sq. ft. (111 sq. m).**
 5. Wide-Range Wall-Switch Sensors:
 - a. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of **1200 sq. ft. (111 sq. m).**
 6. Exterior Occupancy Sensors:
 - a. Description: Passive-infrared type, 120/277 V, weatherproof, adjustable time delay up to 15 minutes, 180-degree field of view, and **110-foot (34-m)** detection range. Minimum switch rating: 1000-W incandescent, 500-VA fluorescent.
- L. Communications Outlets
 1. Telephone Outlet:
 - a. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e. Comply with UL 1863.
 2. Combination TV and Telephone Outlet:
 - a. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e; and one Type F coaxial cable connector.
- M. Wall Plates
 1. Single and combination types to match corresponding wiring devices.
 - a. Plate-Securing Screws: Metal with head color to match plate finish.
 - b. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting **OR** Smooth, high-impact thermoplastic **OR** **0.035-inch- (1-mm-)** thick, satin-finished stainless steel **OR** **0.04-inch- (1-mm-)** thick, brushed brass with factory polymer finish **OR** **0.05-inch- (1.2-mm-)** thick anodized aluminum **OR** **0.04-inch- (1-mm-)** thick steel with chrome-plated finish, **as directed**.
 - c. Material for Unfinished Spaces: Galvanized steel **OR** Smooth, high-impact thermoplastic, **as directed**.
 - d. Material for Damp Locations: Thermoplastic **OR** Cast aluminum, **as directed**, with spring-loaded lift cover, and listed and labeled for use in "wet locations."
 2. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum **OR** thermoplastic, **as directed**, with lockable cover.
- N. Floor Service Fittings
 1. Type: Modular, flush-type **OR** flap-type **OR** above-floor, **as directed**, dual-service units suitable for wiring method used.
 2. Compartments: Barrier separates power from voice and data communication cabling.
 3. Service Plate: Rectangular **OR** Round, **as directed**, die-cast aluminum **OR** solid brass, **as directed**, with satin finish.
 4. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.
 5. Voice and Data Communication Outlet: Blank cover with bushed cable opening **OR** Two modular, keyed, color-coded, RJ-45 Category 5e jacks for UTP cable, **as directed**.
- O. Poke-Through Assemblies

1. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
 - a. Service Outlet Assembly: Pedestal type with services indicated **OR** Flush type with two simplex receptacles and space for two RJ-45 jacks **OR** Flush type with four simplex receptacles and space for four RJ-45 jacks, **as directed**.
 - b. Size: Selected to fit nominal **3-inch (75-mm) OR 4-inch (100-mm)**, **as directed**, cored holes in floor and matched to floor thickness.
 - c. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 - d. Closure Plug: Arranged to close unused **3-inch (75-mm) OR 4-inch (100-mm)**, **as directed**, cored openings and reestablish fire rating of floor.
 - e. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of two **OR** four, **as directed**, 4-pair, Category 5e voice and data communication cables.

P. Multioutlet Assemblies

1. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
2. Raceway Material: Metal, with manufacturer's standard finish **OR** PVC, **as directed**.
3. Wire: No. 12 AWG.

Q. Service Poles

1. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
 - a. Poles: Nominal **2.5-inch- (65-mm-)** square cross section, with height adequate to extend from floor to at least **6 inches (150 mm)** above ceiling, and with separate channels for power wiring and voice and data communication cabling.
 - b. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
 - c. Finishes: Manufacturer's standard painted finish and trim combination **OR** Satin-anodized aluminum, **as directed**.
 - d. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.
 - e. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6 configuration 5-20R units.
 - f. Voice and Data Communication Outlets: Blank insert with bushed cable opening **OR** Two RJ-45 Category 5e jacks **OR** Four RJ-45 Category 5e jacks, **as directed**.

R. Finishes

1. Color: Wiring device catalog numbers in Section Text do not designate device color.
 - a. Wiring Devices Connected to Normal Power System: Almond **OR** Black **OR** Brown **OR** Gray **OR** Ivory **OR** White **OR** As selected, **as directed**, unless otherwise indicated or required by NFPA 70 or device listing.
 - b. Wiring Devices Connected to Emergency Power System: Red.
 - c. TVSS Devices: Blue.
 - d. Isolated-Ground Receptacles: Orange **OR** As specified above, with orange triangle on face, **as directed**.

1.3 EXECUTION

A. Installation

1. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
2. Coordination with Other Trades:

- a. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 - b. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - c. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - d. Install wiring devices after all wall preparation, including painting, is complete.
3. Conductors:
 - a. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 - b. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - c. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - d. Existing Conductors:
 - 1) Cut back and pigtail, or replace all damaged conductors.
 - 2) Straighten conductors that remain and remove corrosion and foreign matter.
 - 3) Pigtailing existing conductors is permitted provided the outlet box is large enough.
4. Device Installation:
 - a. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 - b. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - c. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - d. Connect devices to branch circuits using pigtails that are not less than **6 inches (152 mm)** in length.
 - e. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 - f. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
 - g. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - h. Tighten unused terminal screws on the device.
 - i. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
5. Receptacle Orientation:
 - a. Install ground pin of vertically mounted receptacles up **OR** down, **as directed**, and on horizontally mounted receptacles to the right **OR** left, **as directed**.
 - b. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.
6. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
7. Dimmers:
 - a. Install dimmers within terms of their listing.
 - b. Verify that dimmers used for fan speed control are listed for that application.
 - c. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
8. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
9. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

- B. Identification
1. Comply with Division 26 Section "Identification For Electrical Systems".
 - a. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black **OR** white **OR** red, **as directed**, filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
- C. Field Quality Control
1. Perform tests and inspections and prepare test reports.
 - a. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
 - b. Test Instruments: Use instruments that comply with UL 1436.
 - c. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
 2. Tests for Convenience Receptacles:
 - a. Line Voltage: Acceptable range is 105 to 132 V.
 - b. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 - c. Ground Impedance: Values of up to 2 ohms are acceptable.
 - d. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - e. Using the test plug, verify that the device and its outlet box are securely mounted.
 - f. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
 3. Test straight blade convenience outlets in patient-care areas **OR** hospital-grade convenience outlets, **as directed**, for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).

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Task	Specification	Specification Description
26 05 33 16	26 05 19 16b	Electrical Renovation

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SECTION 26 05 33 23 - 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 grommited 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 26 05 33 23

Task	Specification	Specification Description
26 05 33 23	26 05 33 16	Raceways And Boxes

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SECTION 26 05 36 00 - CABLE TRAYS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of cable trays. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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 steel, aluminum, stainless-steel, and fiberglass cable trays and accessories.

C. Submittals

1. Product Data: Include data indicating dimensions and finishes for each type of cable tray indicated.
2. Shop Drawings: For each type of cable tray.
 - a. Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
 - b. Seismic-Restraint Details, **as directed**: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
 - 1) Design Calculations: Calculate requirements for selecting seismic restraints.
 - 2) Detail fabrication, including anchorages and attachments to structure and to supported cable trays.
3. Field quality-control reports.
4. Operation and Maintenance Data.

D. 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.

E. Delivery, Storage, And Handling

1. Steel cable tray, hot dip galvanized after fabrication, **OR** Aluminum cable tray **OR** Stainless-steel cable tray **OR** Fiberglass cable tray, **as directed** may be stored outside without cover, but shall be loosely stacked, elevated off the ground, and ventilated to prevent staining during storage.
2. Store indoors to prevent water or other foreign materials from staining or adhering to cable tray. Unpack and dry wet materials before storage.
3. Steel, mill galvanized **OR** electrogalvanized **OR** factory-primed, **as directed**, cable tray shall be stored in a well-ventilated, dry location. Unpack and dry wet materials before storage.
4. PVC-coated **OR** Field-painted, **as directed**, cable tray shall be stored indoors. Protect cable tray from scratching and marring of finish. Unpack and dry wet materials before storage.

1.2 PRODUCTS

A. Materials And Finishes

1. Cable Trays, Fittings, and Accessories: Steel, complying with NEMA VE 1.

- a. Factory-standard primer, ready for field painting; with cadmium-plated hardware according to ASTM B 766.
 - b. Mill galvanized before fabrication, complying with ASTM A 653/A 653M, **G90 (Z275)** coating; with hardware galvanized according to ASTM B 633 **OR** cadmium plated according to ASTM B 766, **as directed**.
 - c. Electrogalvanized before fabrication, complying with ASTM B 633; with hardware galvanized according to ASTM B 633.
 - d. Hot-dip galvanized after fabrication, complying with ASTM A 123/A 123M, Class B2; with chromium-zinc, ASTM F 1136, **OR** Type 316 stainless-steel, **as directed**, hardware.
 - e. PVC coating applied in a fluidized bed or by electrostatic spray; with chromium-zinc, ASTM F 1136 **OR** Type 316 stainless-steel, **as directed**, hardware.
 - f. Epoxy-resin paint over paint manufacturer's recommended primer and corrosion-inhibiting treatment; with cadmium-plated hardware according to ASTM B 766 **OR** Type 316 stainless-steel hardware, **as directed**.
2. Cable Trays, Fittings, and Accessories: Aluminum, complying with NEMA VE 1, Aluminum Association's Alloy 6063-T6 for rails, rungs, and cable trays, and Alloy 5052-H32 or Alloy 6061-T6 for fabricated parts; with chromium-zinc, ASTM F 1136, **OR** Type 316 stainless-steel, **as directed**, splice-plate fasteners, bolts, and screws
 3. Cable Trays, Fittings, and Accessories: Stainless steel, Type 304 **OR** 316, **as directed**, complying with NEMA VE 1.
 4. Cable Trays, Fittings, and Accessories: Fiberglass, complying with NEMA FG 1 and UL 568. Splice-plate fasteners, bolts, and screws shall be fiberglass-encapsulated stainless steel. Design fasteners so that no metal is visible when fully assembled and tightened. Fastener encapsulation shall not be damaged when torqued to manufacturer's recommended value.
 5. Sizes and Configurations: Refer to the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
 - a. Center-hanger supports may be used only when specifically indicated.

B. Cable Tray Accessories

1. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
2. Covers: Solid **OR** Louvered **OR** Ventilated-hat **OR** 2-in-3 pitch cover, **as directed**, type of same materials and finishes as cable tray.
3. Barrier Strips: Same materials and finishes as cable tray.
4. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

C. Warning Signs

1. Lettering: **1-1/2-inch- (40-mm-)** high, black letters on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."
2. Materials and fastening are specified in Division 26 Section "Identification For Electrical Systems".

1.3 EXECUTION

A. Cable Tray Installation

1. Comply with recommendations in NEMA VE 2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.
2. Remove burrs and sharp edges from cable trays.
3. Fasten cable tray supports to building structure and install seismic restraints, **as directed**.

- a. Design each fastener and support to carry load indicated by seismic requirements and to comply with seismic-restraint details according to Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
 - b. Place supports so that spans do not exceed maximum spans on schedules.
 - c. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
 - d. Support bus assembly to prevent twisting from eccentric loading.
 - e. Manufacture center-hung support, designed for 60 percent versus 40 percent eccentric loading condition, with a safety factor of 3.
 - f. Locate and install supports according to NEMA FG 1 **OR** NEMA VE 1, **as directed**.
 4. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.
 5. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed dimensions recommended in NEMA FG 1 **OR** NEMA VE 1, **as directed**. Space connectors and set gaps according to applicable standard.
 6. Make changes in direction and elevation using standard fittings.
 7. Make cable tray connections using standard fittings.
 8. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping".
 9. Sleeves for Future Cables: Install capped sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
 10. Workspace: Install cable trays with enough space to permit access for installing cables.
 11. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.
 12. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.
- B. Cable Installation
1. Install cables only when cable tray installation has been completed and inspected.
 2. Fasten cables on horizontal runs with cable clamps or cable ties as recommended by NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
 3. On vertical runs, fasten cables to tray every **18 inches (457 mm)**. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
 4. In existing construction, remove inactive or dead cables from cable tray.
 5. Install covers after installation of cable is completed.
- C. Connections
1. Ground cable trays according to manufacturer's written instructions.
 2. Install an insulated equipment grounding conductor with cable tray, in addition to those required by NFPA 70.
- D. Field Quality Control
1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements. Perform the following field quality-control survey:
 - a. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable tray, vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.
 - b. Verify that the number, size, and voltage of cables in cable tray do not exceed that permitted by NFPA 70. Verify that communication or data-processing circuits are separated from power circuits by barriers.
 - c. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.

- d. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of tray ventilation.
- e. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorquer in suspect areas.
- f. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
- g. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable tray.
- 2. Report results in writing.

E. Protection

- 1. Protect installed cable trays.
 - a. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
 - b. Repair damage to PVC or paint finishes with matching touchup coating recommended by cable tray manufacturer.
 - c. Install temporary protection for cables in open trays to protect exposed cables from falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials until the risk of damage is over.

END OF SECTION 26 05 36 00

Task	Specification	Specification Description
26 05 39 00	26 05 33 23	Underfloor Raceways For Electrical Systems
26 05 43 00	26 05 00 00	Common Work Results for Electrical
26 05 43 00	26 05 19 16	Common Work Results for Communications
26 05 43 00	26 05 19 16a	Common Work Results for Electronic Safety and Security
26 05 43 00	26 05 19 16f	Communications Equipment Room Fittings
26 05 43 00	26 05 19 16g	Communications Backbone Cabling
26 05 43 00	26 05 19 16h	Communications Horizontal Cabling
26 05 43 00	26 05 19 16i	Conductors and Cables for Electronic Safety and Security

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SECTION 26 05 53 00 - ELECTRICAL IDENTIFICATION

1.1 GENERAL

- A. Description Of Work
 - 1. This specification covers the furnishing and installation of materials for electrical identification. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Identification for raceways.
 - b. Identification of power and control cables.
 - c. Identification for conductors.
 - d. Underground-line warning tape.
 - e. Warning labels and signs.
 - f. Instruction signs.
 - g. Equipment identification labels.
 - h. Miscellaneous identification products.
- C. Submittals
 - 1. Product Data: For each electrical identification product indicated.
 - 2. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
 - 3. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
- D. Quality Assurance
 - 1. Comply with ANSI A13.1 and IEEE C2, **as directed**.
 - 2. Comply with NFPA 70.
 - 3. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
 - 4. Comply with ANSI Z535.4 for safety signs and labels.
 - 5. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.2 PRODUCTS

- A. Power Raceway Identification Materials
 - 1. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
 - 2. Colors for Raceways Carrying Circuits at 600 V or Less:
 - a. Black letters on an orange field.
 - b. Legend: Indicate voltage and system or service type, **as directed**.
 - 3. Colors for Raceways Carrying Circuits at More Than 600 V:
 - a. Black letters on an orange field.
 - b. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high letters on 20-inch (500-mm) centers.
 - 4. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

5. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
 6. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, **2 inches (50 mm)** long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
 7. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: **4-inch- (100-mm-)** wide black stripes on **10-inch (250-mm)** centers diagonally over orange background that extends full length of raceway or duct and is **12 inches (300 mm)** wide. Stop stripes at legends.
 8. Metal Tags: Brass or aluminum, **2 by 2 by 0.05 inch (50 by 50 by 1.3 mm)**, with stamped legend, punched for use with self-locking cable tie fastener.
 9. Write-On Tags: Polyester tag, **0.010 inch (0.25 mm) OR 0.015 inch (0.38 mm)**, **as directed**, thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - a. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

OR

Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
- B. Armored And Metal-Clad Cable Identification Materials**
1. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
 2. Colors for Raceways Carrying Circuits at 600 V and Less:
 - a. Black letters on an orange field.
 - b. Legend: Indicate voltage and system or service type, **as directed**.
 3. Colors for Raceways Carrying Circuits at More Than 600 V:
 - a. Black letters on an orange field.
 - b. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with **3-inch- (75-mm-)** high letters on **20-inch (500-mm)** centers.
 4. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

OR

Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; **2 inches (50 mm)** wide; compounded for outdoor use.
- C. Power And Control Cable Identification Materials**
1. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
 2. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
 3. Metal Tags: Brass or aluminum, **2 by 2 by 0.05 inch (50 by 50 by 1.3 mm)**, with stamped legend, punched for use with self-locking cable tie fastener.
 4. Write-On Tags: Polyester tag, **0.010 inch (0.25 mm) OR 0.015 inch (0.38 mm)**, **as directed**, thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - a. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

OR

Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
 5. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

6. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, **2 inches (50 mm)** long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- D. Conductor Identification Materials
1. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than **3 mils (0.08 mm)** thick by **1 to 2 inches (25 to 50 mm)** wide.
 2. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
 3. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
 4. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, **2 inches (50 mm)** long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
 5. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
 6. Write-On Tags: Polyester tag, **0.010 inch (0.25 mm)** **OR 0.015 inch (0.38 mm)**, **as directed**, thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - a. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
OR
Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
- E. Floor Marking Tape
1. **2-inch- (50-mm-)** wide, **5-mil (0.125-mm)** pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.
- F. Underground-Line Warning Tape
1. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 2. Color and Printing:
 - a. Comply with ANSI Z535.1 through ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: **ELECTRIC LINE, HIGH VOLTAGE.**
 - c. Inscriptions for Orange-Colored Tapes: **TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.**
 3. Tag: Type I:
 - a. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Thickness: **4 mils (0.1 mm).**
 - c. Weight: **18.5 lb/1000 sq. ft. (9.0 kg/100 sq. m).**
 - d. **3-Inch (75-mm)** Tensile According to ASTM D 882: **30 lbf (133.4 N)**, and **2500 psi (17.2 MPa).**
 4. Tag: Type II:
 - a. Multilayer laminate consisting of high-density polyethylene scrim coated with pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Thickness: **12 mils (0.3 mm).**
 - c. Weight: **36.1 lb/1000 sq. ft. (17.6 kg/100 sq. m).**

- d. **3-Inch (75-mm)** Tensile According to ASTM D 882: **400 lbf (1780 N)**, and **11,500 psi (79.2 MPa)**.
 5. Tag: Type ID:
 - a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Overall Thickness: **5 mils (0.125 mm)**.
 - c. Foil Core Thickness: **0.35 mil (0.00889 mm)**.
 - d. Weight: **28 lb/1000 sq. ft. (13.7 kg/100 sq. m)**.
 - e. **3-Inch (75-mm)** Tensile According to ASTM D 882: **70 lbf (311.3 N)**, and **4600 psi (31.7 MPa)**.
 6. Tag: Type IID:
 - a. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Overall Thickness: **8 mils (0.2 mm)**.
 - c. Foil Core Thickness: **0.35 mil (0.00889 mm)**.
 - d. Weight: **34 lb/1000 sq. ft. (16.6 kg/100 sq. m)**.
 - e. **3-Inch (75-mm)** Tensile According to ASTM D 882: **300 lbf (1334 N)**, and **12,500 psi (86.1 MPa)**.
- G. Warning Labels And Signs
1. Comply with NFPA 70 and 29 CFR 1910.145.
 2. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
 3. Baked-Enamel Warning Signs:
 - a. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - b. **1/4-inch (6.4-mm)** grommets in corners for mounting.
 - c. Nominal size, **7 by 10 inches (180 by 250 mm)**.
 4. Metal-Backed, Butyrate Warning Signs:
 - a. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with **0.0396-inch (1-mm)** galvanized-steel backing; and with colors, legend, and size required for application.
 - b. **1/4-inch (6.4-mm)** grommets in corners for mounting.
 - c. Nominal size, **10 by 14 inches (250 by 360 mm)**.
 5. Warning label and sign shall include, but are not limited to, the following legends:
 - a. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - b. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR **36 INCHES (915 MM)**."
- H. Instruction Signs
1. Engraved, laminated acrylic or melamine plastic, minimum **1/16 inch (1.6 mm)** thick for signs up to **20 sq. inches (129 sq. cm)** and **1/8 inch (3.2 mm)** thick for larger sizes.
 - a. Engraved legend with black letters on white face.
 - b. Punched or drilled for mechanical fasteners.
 - c. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
 2. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be **3/8 inch (10 mm)**.
 3. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be **3/8 inch (10 mm)**. Overlay shall provide a weatherproof and UV-resistant seal for label.

- I. Equipment Identification Labels
 - 1. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be **3/8 inch (10 mm)**.
 - 2. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be **3/8 inch (10 mm)**. Overlay shall provide a weatherproof and UV-resistant seal for label.
 - 3. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be **3/8 inch (10 mm)**.
 - 4. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be **3/8 inch (10 mm)**.
 - 5. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be **1 inch (25 mm)**.
- J. Cable Ties
 - 1. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - a. Minimum Width: **3/16 inch (5 mm)**.
 - b. Tensile Strength at **73 deg F (23 deg C)**, According to ASTM D 638: **12,000 psi (82.7 MPa)**.
 - c. Temperature Range: **Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**.
 - d. Color: Black except where used for color-coding.
 - 2. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - a. Minimum Width: **3/16 inch (5 mm)**.
 - b. Tensile Strength at **73 deg F (23 deg C)**, According to ASTM D 638: **12,000 psi (82.7 MPa)**.
 - c. Temperature Range: **Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)**.
 - d. Color: Black.
 - 3. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
 - a. Minimum Width: **3/16 inch (5 mm)**.
 - b. Tensile Strength at **73 deg F (23 deg C)**, According to ASTM D 638: **7000 psi (48.2 MPa)**.
 - c. UL 94 Flame Rating: 94V-0.
 - d. Temperature Range: **Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C)**.
 - e. Color: Black.
- K. Miscellaneous Identification Products
 - 1. Paint: Comply with requirements in Division 07 for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
 - 2. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

1.3 EXECUTION

- A. Installation
 - 1. Verify identity of each item before installing identification products.
 - 2. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
 - 3. Apply identification devices to surfaces that require finish after completing finish work.
 - 4. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
 - 5. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 - 6. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at **50-foot**

(15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

7. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
8. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - a. Outdoors: UV-stabilized nylon.
 - b. In Spaces Handling Environmental Air: Plenum rated.
9. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.
10. Painted Identification: Comply with requirements in Division 07 for surface preparation and paint application.

B. Identification Schedule

1. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high black letters on 20-inch (500-mm) centers. Stop stripes at legends. Apply to the following finished surfaces:
 - a. Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
 - b. Wall surfaces directly external to raceways concealed within wall.
 - c. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
2. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Self-adhesive vinyl **OR** Snap-around, **as directed**, labels. Install labels at 10-foot (3-m) **OR** 30-foot (10-m), **as directed**, maximum intervals.
3. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label **OR** self-adhesive vinyl tape applied in bands, **as directed**. Install labels at 10-foot (3-m) **OR** 30-foot (10-m), **as directed**, maximum intervals.
4. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
 - a. Emergency Power.
 - b. Power.
 - c. UPS.
5. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - a. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - 1) Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - 2) Colors for 208/120-V Circuits:
 - a) Phase A: Black.
 - b) Phase B: Red.
 - c) Phase C: Blue.
 - 3) Colors for 480/277-V Circuits:
 - a) Phase A: Brown.
 - b) Phase B: Orange.
 - c) Phase C: Yellow.
 - 4) Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where

- splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
6. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags **OR** nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation, **as directed**.
 7. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
 8. Conductors to Be Extended in the Future: Attach write-on tags **OR** marker tape, **as directed**, to conductors and list source.
 9. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - a. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - b. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - c. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
 10. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 - a. Limit use of underground-line warning tape to direct-buried cables.
 - b. Install underground-line warning tape for both direct-buried cables and cables in raceway.
 11. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
 12. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels **OR** Baked-enamel warning signs **OR** Metal-backed, butyrate warning signs, **as directed**.
 - a. Comply with 29 CFR 1910.145.
 - b. Identify system voltage with black letters on an orange background.
 - c. Apply to exterior of door, cover, or other access.
 - d. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - 1) Power transfer switches.
 - 2) Controls with external control power connections.
 13. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
 14. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum **3/8-inch- (10-mm-)** high letters for emergency instructions at equipment used for power transfer **OR** load shedding, **as directed**.
 15. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 - a. Labeling Instructions:
 - 1) Indoor Equipment: Adhesive film label **OR** Adhesive film label with clear protective overlay **OR** Self-adhesive, engraved, laminated acrylic or melamine label **OR** Engraved, laminated acrylic or melamine label, **as directed**. Unless otherwise indicated, provide a single line of text with **1/2-inch- (13-mm-)** high letters on **1-1/2-inch- (38-mm-)** high label; where two lines of text are required, use labels **2 inches (50 mm)** high.
 - 2) Outdoor Equipment: Engraved, laminated acrylic or melamine label **OR** Stenciled legend **4 inches (100 mm)** high, **as directed**.

- 3) Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
- 4) Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
- b. Equipment to Be Labeled:
 - 1) Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved **OR** engraved, **as directed**, laminated acrylic or melamine label.
 - 2) Enclosures and electrical cabinets.
 - 3) Access doors and panels for concealed electrical items.
 - 4) Switchgear.
 - 5) Switchboards.
 - 6) Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - 7) Substations.
 - 8) Emergency system boxes and enclosures.
 - 9) Motor-control centers.
 - 10) Enclosed switches.
 - 11) Enclosed circuit breakers.
 - 12) Enclosed controllers.
 - 13) Variable-speed controllers.
 - 14) Push-button stations.
 - 15) Power transfer equipment.
 - 16) Contactors.
 - 17) Remote-controlled switches, dimmer modules, and control devices.
 - 18) Battery-inverter units.
 - 19) Battery racks.
 - 20) Power-generating units.
 - 21) Monitoring and control equipment.
 - 22) UPS equipment.

END OF SECTION 26 05 53 00

SECTION 26 05 53 00a - INTERCOMMUNICATIONS AND PROGRAM SYSTEMS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for intercommunications and program 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. Section Includes: Manually switched and Microprocessor-switched intercommunications and program systems with the following components:
 - a. Master stations.
 - b. Speaker-microphone stations.
 - c. Call-switch unit.
 - d. All-call amplifier.
 - e. Intercommunication amplifier.
 - f. Paging amplifier.
 - g. Loudspeakers/speaker microphones.
 - h. Conductors and cables.
 - i. Raceways.

C. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: For intercommunications and program systems. Include plans, elevations, sections, details, and attachments to other work.
 - a. Wiring Diagrams: For power, signal, and control wiring.
 - 1) Identify terminals to facilitate installation, operation, and maintenance.
 - 2) Single-line diagram showing interconnection of components.
 - 3) Cabling diagram showing cable routing.
3. Field quality-control reports.
4. Operation and maintenance data.

D. Quality Assurance

1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with NFPA 70.

1.2 PRODUCTS

A. Functional Description Of Manually Switched Systems

1. Master Station:
 - a. Communicating selectively with other master and speaker-microphone stations by actuating selector switches.
 - b. Communicating simultaneously with all other stations by actuating a single all-call switch.
 - c. Communicating with individual stations in privacy.
 - d. Including other master-station connections in a multiple-station conference call.
 - e. Accessing separate paging speakers or groups of paging speakers by actuating selector switches.
 - f. Overriding any conversation by a designated master station.

2. Speaker-Microphone Station:
 - a. Having privacy from remote monitoring without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls.
 - b. Communicating hands free.
 - c. Calling master station by actuating call switch.
 - d. Returning a busy signal to indicate that station is already in use.
 - e. Being free of noise and distortion during operation and when in standby mode.
 3. Speakers: Free of noise and distortion during operation and when in standby mode.
- B. Functional Description Of Microprocessor-Switched Systems
1. Master Station:
 - a. Communicating selectively with other master and speaker-microphone stations by dialing station's number on a 12-digit keypad.
 - b. Communicating simultaneously with all other stations by dialing a designated number on a 12-digit keypad.
 - c. Communicating with individual stations in privacy.
 - d. Including other master-station connections in a multiple-station conference call.
 - e. Accessing separate paging speakers or groups of paging speakers by dialing designated numbers on a 12-digit keypad.
 - f. Overriding any conversation by a designated master station.
 - g. Displaying selected station.
 2. Speaker-Microphone Station:
 - a. Having privacy from remote monitoring without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls.
 - b. Communicating hands free.
 - c. Calling master station by actuating call switch.
 - d. Returning a busy signal to indicate that station is already in use.
 - e. Being free of noise and distortion during operation and when in standby mode.
 3. Speakers: Free of noise and distortion during operation and when in standby mode.
- C. General Requirements For Equipment And Materials
1. Coordinate features and select components to form an integrated system. Match components and interconnections for optimum performance of specified functions.
 2. Expansion Capability: Increase number of stations in the future by 25 percent above those indicated without adding any internal or external components or main trunk cable conductors.
 3. Equipment: Modular type using solid-state components, fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
 4. Weather-Resistant Equipment: Listed and labeled by an NRTL for duty outdoors or in damp locations.
- D. Master Station For Manually Switched Systems
1. Station-Selector and Talk-Listen Switches: Heavy-duty type with gold-plated contacts rated for five million operations.
 2. Volume Control: Regulates incoming-call volume.
 3. LED Annunciation: Identifies calling stations and stations in use. LED remains on until call is answered.
 4. Tone Annunciation: Momentary audible tone signal announces incoming calls.
 5. Speaker Microphone: Transmits and receives calls.
 6. Handset with Hook Switch: Telephone type with **18-inch- (450-mm-)** long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.
 7. Equipment Cabinet: Comply with TIA/EIA-310-D. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, and auxiliary equipment.

- E. Master Station For Microprocessor-Switched Systems
 - 1. 12-Digit Keypad Selector: Transmits calls to other stations and initiates commands for programming and operation.
 - 2. Volume Control: Regulates incoming-call volume.
 - 3. LED Annunciation: Identifies calling stations and stations in use. LED remains on until call is answered.
 - 4. Tone Annunciation: Momentary audible tone signal announces incoming calls.
 - 5. Handset with Hook Switch: Telephone type with 18-inch- (450-mm-) long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.
 - 6. Reset Control: Cancels call and resets system for next call.
 - 7. Equipment Cabinet: Comply with TIA/EIA-310-D. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, and other switching and control devices required for conversation channels and control functions.
- F. Speaker-Microphone Stations
 - 1. Mounting: Flush unless otherwise indicated, and suitable for mounting conditions indicated.
 - 2. Faceplate: Stainless steel or anodized aluminum with tamperproof mounting screws.
 - 3. Back Box: Two-gang galvanized steel with 2-1/2-inch (64-mm) minimum depth.
 - 4. Speaker: 3 inches (76 mm), 2.3 oz. (65 g) minimum; permanent magnet.
 - 5. Tone Annunciation: Recurring momentary tone indicates incoming calls.
 - 6. Call Switch: Mount on faceplate. Permits calls to master station.
 - 7. Privacy Switch: Mount on faceplate. When in on position, switch prevents transmission of sound from remote station to system; when in off position, without further switch manipulation, response can be made to incoming calls.
 - 8. Handset with Hook Switch: Telephone type with 18-inch- (450-mm-) long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.
- G. Call-Switch Unit
 - 1. Enclosure: Single-gang box with stainless-steel faceplate.
 - 2. Call Switch: Momentary contact signals system that a call has been placed.
 - 3. Privacy Switch: Prevents transmission of sound signals from station to system.
 - 4. Volume Control: Operated by screwdriver blade through a hole in faceplate to adjust output level of associated speaker.
 - 5. Handset with Hook Switch: Telephone type with 18-inch- (450-mm-) long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.
- H. All-Call Amplifier
 - 1. Output Power: 70-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus an allowance for future stations.
 - 2. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to quantity of stations connected in all-call mode of operation.
 - 3. Minimum Signal-to-Noise Ratio: 45 dB, at rated output.
 - 4. Frequency Response: Within plus or minus 3 dB from 70 to 12,000 Hz.
 - 5. Output Regulation: Maintains output level within 2 dB from full to no load.
 - 6. Input Sensitivity: Compatible with master stations and central equipment so amplifier delivers full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on master stations, speaker microphones, or handset transmitters.
 - 7. Amplifier Protection: Prevents damage from shorted or open output.
- I. Intercommunication Amplifier
 - 1. Minimum Output Power: 2 W; adequate for all functions.
 - 2. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to one station connected to output terminals.
 - 3. Minimum Signal-to-Noise Ratio: 45 dB, at rated output.
 - 4. Frequency Response: Within plus or minus 3 dB from 70 to 10,000 Hz.

5. Output Regulation: Maintains output level within 2 dB from full to no load.
 6. Input Sensitivity: Matched to input circuit and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on master stations, speaker microphones, or handset transmitters.
 7. Amplifier Protection: Prevents damage from shorted or open output.
- J. Paging Amplifier
1. Input Voltage: 120-V ac, 60 Hz.
 2. Frequency Response: Within plus or minus 3 dB from 60 to 10,000 Hz.
 3. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.
 4. Total Harmonic Distortion: Less than 3 percent at rated power output from 70 to 12,000 Hz.
 5. Output Regulation: Less than 2 dB from full to no load.
 6. Controls: On-off, input levels, and low-cut filter.
 7. Input Sensitivity: Matched to input circuit and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphones or handset transmitters.
 8. Amplifier Protection: Prevents damage from shorted or open output.
 9. Output Circuit: 70-V line.
- K. Cone-Type Loudspeakers/Speaker Microphones
1. Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.
 2. Frequency Response: Within plus or minus 3 dB from 70 to 15,000 Hz.
 3. Minimum Dispersion Angle: 100 degrees.
 4. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.
 5. Enclosures: Steel housings or back boxes, acoustically dampened, with front face of at least **0.0478-inch (1.2-mm)** steel and whole assembly rust proofed and factory primed; complete with mounting assembly and suitable for surface ceiling, flush ceiling, pendant or wall mounting; with relief of back pressure.
 6. Baffle: For flush speakers, minimum thickness of **0.032-inch (0.8-mm)** aluminum brushed to a satin sheen and lacquered **OR** with textured white finish, **as directed**.
 7. Vandal-Proof, High-Strength Baffle: For flush **OR** surface, **as directed**, mounted speakers, self-aging cast aluminum with tensile strength of **44,000 psi (303 MN/sq. m)**, **0.025-inch (0.65-mm)** minimum thickness; countersunk heat-treated alloy mounting screws; and textured white epoxy finish.
 8. Size: **8 inches (200 mm)** with **1-inch (25-mm)** voice coil and minimum **5-oz. (140-g)** ceramic magnet.
- L. Horn-Type Loudspeakers/Speaker Microphones
1. Speakers shall be all-metal, weatherproof construction; complete with universal mounting brackets.
 2. Frequency Response: Within plus or minus 3 dB from 275 to 14,000 Hz.
 3. Minimum Power Rating of Driver: 15 W, continuous.
 4. Minimum Dispersion Angle: 110 degrees.
 5. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.
- M. Horn-Type Explosion-Proof Loudspeakers
1. Speakers shall be all-metal construction; complete with universal mounting brackets.
 2. Units in Hazardous (Classified) Locations: Listed and labeled for environment in which they are located.
 3. Frequency Response: Within plus or minus 3 dB from 300 to 12,000 Hz.
 4. Minimum Power Rating of Driver: 30 **OR** 60, **as directed**, W, continuous.
 5. Minimum Dispersion Angle: 95 **OR** 60 by 120, **as directed**, degrees.
 6. Line Transformer: Internally mounted and factory installed, power rating equal to speaker's, and at least four level taps.

- N. Conductors And Cables
1. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.
 2. Insulation: Thermoplastic, not less than **1/32 inch (0.8 mm)** thick.
 3. Shielding: For speaker-microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil.
 - a. Minimum Shielding Coverage on Conductors: 60 percent.
 4. Plenum Cable: Listed and labeled for plenum installation.
- O. Raceways
1. Intercommunication and Program System Raceways and Boxes: Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems".
 2. Intercommunication and Program System Raceways and Boxes: Same as required for electrical branch circuits specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
 3. Intercommunication and Program System Raceways and Boxes: EMT **OR** ENT **OR** RNC **OR** Optical-fiber/communication raceways and fittings **OR** Metal wireways **OR** Nonmetal wireways **OR** Surface metal raceways **OR** Surface nonmetal raceways, **as directed**.
 4. Outlet boxes shall be not less than **2 inches (50 mm)** wide, **3 inches (75 mm)** high, and **2-1/2 inches (64 mm)** deep.
 5. Flexible metal conduit is prohibited.

1.3 EXECUTION

- A. Wiring Methods
1. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
 - a. Install plenum cable in environmental air spaces, including plenum ceilings.
 - b. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
 2. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
 3. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- B. Installation Of Raceways
1. Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems" for installation of conduits and wireways.
 2. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- C. Installation Of Cables
1. Comply with NECA 1.
 2. General Requirements:
 - a. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
 - b. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
 - c. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - d. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

- e. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
- f. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.
- 3. Open-Cable Installation:
 - a. Install cabling with horizontal and vertical cable guides in telecommunication spaces with terminating hardware and interconnection equipment.
 - b. Suspend speaker cable not in a wireway or pathway a minimum of **8 inches (200 mm)** above ceiling by cable supports not more than **60 inches (1524 mm)** apart.
 - c. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.
- 4. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least **12 inches (300 mm)** apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

D. Installation

- 1. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
- 2. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
- 3. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
- 4. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.
- 5. Connect wiring according to Division 26 Section "Grounding And Bonding For Electrical Systems".

E. Grounding

- 1. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- 2. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.
- 3. Install grounding electrodes as specified in Division 26 Section "Grounding And Bonding For Electrical Systems".

F. System Programming

- 1. Programming: Fully brief the Owner on available programming options. Record the Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

G. 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. Schedule tests with at least seven days' advance notice of test performance.
 - b. After installing intercommunications and program systems and after electrical circuitry has been energized, test for compliance with requirements.
 - c. Operational Test: Test originating station-to-station, all-call, and page messages at each intercommunication station. Verify proper routing and volume levels and that system is

- free of noise and distortion. Test each available message path from each station on system.
- d. Frequency Response Test: Determine frequency response of two transmission paths, including all-call and paging, by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 150 to 2500 Hz.
 - e. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
 - 1) Disconnect speaker microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure signal-to-noise ratio at speakers or paging speakers.
 - 2) Repeat test for four speaker microphones and for each separately controlled zone of paging loudspeakers.
 - 3) Minimum acceptable ratio is 35 dB.
 - f. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into each paging and all-call amplifier, and a minimum of two selected intercommunication amplifiers. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics.
 - g. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at three locations in each paging zone. Maximum permissible variation in level is plus or minus 3 dB; in levels between adjacent zones, plus or minus 5 dB.
 - h. Power Output Test: Measure electrical power output of each paging amplifier at normal gain settings of 150, 1000, and 2500 Hz. Maximum variation in power output at these frequencies is plus or minus 3 dB.
 - i. Signal Ground Test: Measure and report ground resistance at system signal ground. Comply with testing requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".
3. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.
 4. Intercommunications and program systems will be considered defective if they do not pass tests and inspections.
 5. Prepare test and inspection reports.

END OF SECTION 26 05 53 00a

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Task	Specification	Specification Description
26 27 16 00	01 22 16 00	No Specification Required
26 27 16 00	26 05 33 16	Raceways And Boxes
26 27 23 00	26 05 33 16a	Wiring Devices
26 27 26 00	26 05 33 16	Raceways And Boxes
26 27 26 00	26 05 33 16a	Wiring Devices
26 27 73 00	26 05 33 16a	Wiring Devices

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SECTION 26 33 43 00 - CENTRAL BATTERY INVERTERS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for central battery inverters. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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 slow-transfer, fast-transfer, and UPS central battery inverters with the following features:
 - a. Output distribution section.
 - b. Internal maintenance bypass/isolation switch.
 - c. External maintenance bypass/isolation switch.
 - d. Multiple output voltages.
 - e. Emergency-only circuits.
 - f. Remote monitoring provisions.

C. Definitions

1. LCD: Liquid-crystal display.
2. LED: Light-emitting diode.
3. THD: Total harmonic distortion.
4. UPS: Uninterruptible power supply.

D. Submittals

1. Product Data: For the following:
 - a. Electrical ratings, including the following:
 - 1) Capacity to provide power during failure of normal ac.
 - 2) Inverter voltage regulation and THD of output current.
 - 3) Rectifier data.
 - 4) Transfer time of transfer switch.
 - 5) Data for specified optional features.
 - b. Transfer switch.
 - c. Inverter.
 - d. Battery charger.
 - e. Batteries.
 - f. Battery monitoring.
 - g. Battery-cycle warranty monitor.
2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
 - a. Wiring Diagrams: Detail internal and interconnecting wiring; and power, signal, and control wiring.
 - b. Elevation and details of control and indication displays.
 - c. Output distribution section.
3. Manufacturer Seismic Qualification Certification: Submit certification that central battery inverter equipment will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
4. Operation and Maintenance Data.

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. Central Battery Inverter System: UL 924 and UL 1778, **as directed**, listed.
3. Comply with NFPA 70 and NFPA 101.

F. Delivery, Storage, And Handling

1. Deliver equipment in fully enclosed vehicles.
2. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for non-operating equipment.

G. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.
 - a. Warranty Period: Include the following warranty periods, from date of Final Completion:
 - 1) Premium, Valve-Regulated, Recombinant, Lead-Calcium Batteries:
 - a) Full Warranty: One year.
 - b) Pro Rata: 19 years.
 - 2) Standard, Valve-Regulated, Recombinant, Lead-Calcium Batteries:
 - a) Full Warranty: One year.
 - b) Pro Rata: Nine years.
 - 3) Nickel-Cadmium, Wet-Cell Batteries:
 - a) Full Warranty: Five years.
 - b) Pro Rata: 15 years.
 - 4) Lead-Calcium, Wet-Cell Batteries:
 - a) Full Warranty: One year.
 - b) Pro Rata: Nine years.
 - 5) Lead-Antimony, Wet-Cell Batteries:
 - a) Full Warranty: One year.
 - b) Pro Rata: Nine years.

1.2 PRODUCTS

A. Inverter Performance Requirements

1. Slow-Transfer Central Battery Inverters: Automatically sense loss of normal ac supply and use an electromechanical switch to transfer loads. Transfer in one second or less from normal supply to battery-inverter supply.
 - a. Operation: Unit supplies power to output circuits from a single, external, normal supply source. Unit automatically transfers load from normal source to internal battery/inverter source. Retransfer to normal is automatic when normal power is restored.
2. Fast-Transfer Central Battery Inverters: Automatically sense loss of normal ac supply and use a solid-state switch to transfer loads. Transfer in 0.004 second or less from normal supply to battery-inverter supply.
 - a. Operation: Unit supplies power to output circuits from a single, external, normal supply source. Unit automatically transfers load from normal source to internal battery/inverter source. Retransfer to normal is automatic when normal power is restored.
3. UPS-Type Central Battery Inverters: Continuously provide ac power to connected electrical system.
 - a. Automatic Operation:
 - 1) Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, through rectifier-charger and inverter, with battery connected in parallel with rectifier-charger output.

- 2) Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, battery supplies constant, regulated, inverter ac power output to the load without switching or disturbance.
 - 3) If normal power fails, battery continues supply-regulated ac power through the inverter to the load without switching or disturbance.
 - 4) When power is restored at normal supply terminals of system, controls automatically synchronize inverter with the external source before transferring the load. Rectifier-charger then supplies power to the load through the inverter and simultaneously recharges battery.
 - 5) If battery becomes discharged and normal supply is available, rectifier-charger charges battery. When battery is fully charged, rectifier-charger automatically shifts to float-charge mode.
 - 6) If any element of central battery inverter system fails and power is available at normal supply terminals of system, static bypass transfer switch transfers the load to normal ac supply circuit without disturbance or interruption of supply.
 - 7) If a fault occurs in system supplied by central battery inverter and current flows in excess of the overload rating of central battery inverter system, static bypass transfer switch operates to bypass fault current to normal ac supply circuit for fault clearing.
 - 8) When fault has cleared, static bypass transfer switch returns the load to central battery inverter system.
 - 9) If battery is disconnected, central battery inverter continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.
 - b. Manual Operation:
 - 1) Turning inverter off causes static bypass transfer switch to transfer the load directly to normal ac supply circuit without disturbance or interruption.
 - 2) Turning inverter on causes static bypass transfer switch to transfer the load to inverter.
 4. Maximum Acoustical Noise: **<Insert value>** dB, "A" weighting, emanating from any UPS component under any condition of normal operation, measured **39 inches (990 mm)** from nearest surface of component enclosure.
- B. Service Conditions
1. Environmental Conditions: Inverter system shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 - a. Ambient Temperature for Electronic Components: **32 to 98 deg F (0 to 37 deg C)**.
 - b. Relative Humidity: 0 to 95 percent, noncondensing.
 - c. Altitude: Sea level to **4000 feet (1220 m)**.
- C. Inverters
1. Description: Solid-state type, with the following operational features:
 - a. Automatically regulate output voltage to within plus or minus 5 percent.
 - b. Automatically regulate output frequency to within plus or minus 1 Hz, from no load to full load at unit power factor over the operating range of battery voltage.
 - c. Output Voltage Waveform of Unit: Sine wave with maximum 10 percent THD throughout battery operating-voltage range, from no load to full load.
 - 1) THD may not exceed 5 percent when serving a resistive load of 100 percent of unit rating.
 - d. Output Protection: Current-limiting and short-circuit protection.
OR
Output Protection: Ferroresonant transformer to provide inherent overload and short-circuit protection.
 - e. Surge Protection: Panelboard **OR** Auxiliary panel, **as directed**, suppressors specified in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits".

- f. Overload Capability: 125 percent for 10 minutes; 150 percent surge.
- g. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.

D. Battery Charger

- 1. Description: Solid-state, automatically maintaining batteries in fully charged condition when normal power is available. With LED indicators for "float" and "high-charge" modes.

E. Batteries

- 1. Description: Premium, valve-regulated, recombinant, lead-calcium **OR** Standard, valve-regulated, recombinant, lead-calcium **OR** Nickel-cadmium, wet-cell **OR** Lead-calcium, wet-cell **OR** Lead-antimony, wet-cell, **as directed**, batteries.
 - a. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.

F. Enclosures

- 1. NEMA 250, Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.
- 2. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.

G. Seismic Requirements

- 1. Central battery inverter assemblies, subassemblies, components, fastenings, supports, and mounting and anchorage devices shall be designed and fabricated to withstand seismic forces, **as directed**. The term "withstand" is defined in the "Manufacturer Seismic Qualification Certification" Paragraph in Part 1.1 "Submittals" Article.

H. Control And Indication

- 1. Description: Group displays, indications, and basic system controls on common control panel on front of central battery inverter enclosure.
- 2. Minimum displays, indicating devices, and controls shall include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms shall include an audible signal and a visual display.
- 3. Indications: Labeled LED **OR** Plain-language messages on a digital LCD or LED, **as directed**.
 - a. Quantitative Indications:
 - 1) Input voltage, each phase, line to line.
 - 2) Input current, each phase, line to line.
 - 3) System output voltage, each phase, line to line.
 - 4) System output current, each phase.
 - 5) System output frequency.
 - 6) DC bus voltage.
 - 7) Battery current and direction (charge/discharge).
 - 8) Elapsed time-discharging battery.
 - b. Basic Status Condition Indications:
 - 1) Normal operation.
 - 2) Load-on bypass.
 - 3) Load-on battery.
 - 4) Inverter off.
 - 5) Alarm condition exists.
 - c. Alarm Indications:
 - 1) Battery system alarm.
 - 2) Control power failure.
 - 3) Fan failure.
 - 4) Overload.
 - 5) Battery-charging control faulty.
 - 6) Input overvoltage or undervoltage.
 - 7) Approaching end of battery operation.

- 8) Battery undervoltage shutdown.
- 9) Inverter fuse blown.
- 10) Inverter transformer overtemperature.
- 11) Inverter overtemperature.
- 12) Static bypass transfer switch overtemperature.
- 13) Inverter power supply fault.
- 14) Inverter output overvoltage or undervoltage.
- 15) System overload shutdown.
- 16) Inverter output contactor open.
- 17) Inverter current limit.
- d. Controls:
 - 1) Inverter on-off.
 - 2) Start.
 - 3) Battery test.
 - 4) Alarm silence/reset.
 - 5) Output-voltage adjustment.
4. Dry-form "C" contacts shall be available for remote indication of the following conditions:
 - a. Inverter on battery.
 - b. Inverter on-line.
 - c. Inverter load-on bypass.
 - d. Inverter in alarm condition.
 - e. Inverter off (maintenance bypass closed).
5. Include the following minimum array:
 - a. Ready, normal-power on light.
 - b. Charge light.
 - c. Inverter supply load light.
 - d. Battery voltmeter.
 - e. AC output voltmeter with minimum accuracy of 2 percent of full scale.
 - f. Load ammeter.
 - g. Test switch to simulate ac failure.
6. Enclosure: Steel, with hinged lockable doors, suitable for wall **OR** floor, **as directed**, mounting. Manufacturer's standard corrosion-resistant finish.
- I. Optional Features
 1. Multiple Output Voltages: Supply unit branch circuits at different voltage levels if required. Transform voltages internally as required to produce indicated output voltages.
 2. Emergency-Only Circuits: Automatically energize only when normal supply has failed. Disconnect emergency-only circuits when normal power is restored.
 3. Maintenance Bypass/Isolation Switch: Load is supplied, bypassing central battery inverter system. Normal supply, electromechanical transfer switch, and system load terminals are completely disconnected from external circuits.
 4. Maintenance Bypass/Isolation Switch: Switch is interlocked so it cannot be operated unless static bypass transfer switch is in bypass mode. Switch provides manual selection among the following three conditions without interrupting supply to the load during switching:
 - a. Full Isolation: Load is supplied, bypassing central battery inverter system. Normal ac input circuit, static bypass transfer switch, and central battery inverter load terminals are completely disconnected from external circuits.
 - b. Maintenance Bypass: Load is supplied, bypassing central battery inverter system. Central battery inverter ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
 - c. Normal: Normal central battery inverter ac supply terminals are energized and the load is supplied either through static bypass transfer switch and central battery inverter rectifier-charger and inverter or through battery and inverter.
- J. Output Distribution Section

1. Panelboard: Comply with Division 26 Section "Panelboards" except provide assembly integral to equipment cabinet.

K. System Monitoring And Alarms

1. Remote Status and Alarm Panel: Labeled LEDs on panel faceplate shall indicate five basic status conditions. Audible signal indicates alarm conditions. Silencing switch in face of panel silences signal without altering visual indication.
 - a. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.
2. Provisions for Remote Computer Monitoring: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms specified in Part 1.2 "Control and Indication" Article. Remote computer and connecting signal wiring will be provided by the Owner. Include the following features:
 - a. Connectors and network interface units or modems for data transmission via RS-232 link.
 - b. Software shall be designed to control and monitor inverter system functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of reports. Include capability for storage and analysis of power-line transient records. Software shall be compatible with requirements in Division 26 Section "Electrical Power Monitoring And Control" and the operating system and configuration of the Owner-furnished computers.
3. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.
 - a. Annunciation of Alarms: At inverter system control panel.
4. Battery-Cycle Warranty Monitoring: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring charge-discharge cycle history of batteries covered by cycle-life warranty.
 - a. Basic Functional Performance: Automatically measures and records each discharge event, classifies it according to duration category, and totals discharges according to warranty criteria, displaying remaining warranted battery life on integral LCD.
 - b. Additional monitoring functions and features shall include the following:
 - 1) Measuring and recording of total voltage at battery terminals; providing alarm for excursions outside proper float voltage level.
 - 2) Monitoring of ambient temperature at battery and initiating an alarm if temperature deviates from normally acceptable range.
 - 3) Keypad on device front panel provides access to monitored data using front panel display.
 - 4) Alarm contacts arranged to provide local **OR** remote, **as directed**, alarm for battery discharge events **OR** abnormal temperature **OR** abnormal battery voltage or temperature, **as directed**.
 - 5) Memory device to store recorded data in nonvolatile electronic memory.
 - 6) RS-232 port to permit downloading of data to a portable personal computer.
 - 7) Modem to make measurements and recorded data accessible to remote personal computer via telephone line. Computer will be provided by the Owner.

L. Source Quality Control

1. Factory test complete inverter system, including battery, before shipment. Include the following:
 - a. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
 - b. Full-load test.
 - c. Transient-load response test.
 - d. Overload test.
 - e. Power failure test.
2. Observation of Test: Give 14 days' advance notice of tests and provide access for the Owner's representative to observe tests at the Owner's option.
3. Report test results. Include the following data:

- a. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
- b. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
- c. List of instruments and equipment used in factory tests.

1.3 EXECUTION

A. Installation

1. Install system components on floor **OR** concrete base, **as directed**, and attach by bolting.
 - a. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Vibration And Seismic Controls For Electrical Systems" for seismic-restraint requirements.
 - b. Concrete Bases: **4 inches (100 mm)** high, reinforced, with chamfered edges. Extend base no more than **3 inches (75 mm)** in all directions beyond the maximum dimensions of switchgear unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers And Supports For Electrical Systems".
 - c. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 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. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

B. Connections

1. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.
2. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
 - a. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.
3. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Identification

1. Identify equipment and components according to Division 26 Section "Identification For Electrical Systems".

D. Field Quality Control

1. Perform tests and inspections and prepare test reports.
 - 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. Inspect interiors of enclosures for integrity of mechanical and electrical connections, component type and labeling verification, and ratings of installed components.
 - b. Test manual and automatic operational features and system protective and alarm functions.
 - c. Test communication of status and alarms to remote monitoring equipment.
 - d. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specifications. Certify compliance with test parameters.

- e. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- 3. Remove and replace malfunctioning units and retest as specified above.

E. Startup Service

- 1. Engage a factory-authorized service representative to perform startup service.
- 2. Verify that central battery inverter is installed and connected according to the Contract Documents.
- 3. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 22.
- 4. Complete installation and startup checks according to manufacturer's written instructions.

F. Adjusting And Cleaning

- 1. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- 2. Install new filters in each equipment cabinet within 14 days from date of Final Completion.

END OF SECTION 26 33 43 00

SECTION 26 33 43 00a - NURSE CALL

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for nurse call. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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 visual/tone and audiovisual/voice nurse-call system.

C. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - a. Detail equipment cabinets and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - b. Cabling Diagrams: Single-line block diagrams showing cabling interconnection of all components for this specific equipment. Include cable type for each interconnection.
 - c. Station Installation Details: For built-in equipment, dimensioned and to scale.
3. Qualification Data: For qualified Installer.
4. Field quality-control reports.
5. Operation and Maintenance Data: For nurse-call equipment to include in emergency, operation, and maintenance manuals.
6. Warranty: Sample of special warranty.

D. Quality Assurance

1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Compatibility: System shall be capable of integration with any brand of phone system (wired or wireless), staff locating system, CCTV, and fire-alarm system.
3. Electrical Components, Devices, and Accessories: Listed and labeled according to UL 1069 as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty for batteries applies to materials only, on a prorated basis for specified period.
 - a. Warranty Period: Include the following warranty periods, from date of Final Completion:
 - 1) Nickel-Cadmium Batteries, Lithium Batteries, and Wet-Cell Batteries:
 - a) Full Warranty: Five years.
 - b) Pro Rata: 15 years.

1.2 PRODUCTS

A. Nurse-Call System General Requirements

1. Station Zones: Able to program 256 station zones for each master station in the network with eight priority levels and addressable visual and audible annunciation of audible devices such as smoke detectors and door contacts.
2. System shall provide integrated and centralized "Code Blue" and "Staff Emergency" calls.

3. Expansion Capability: Equipment ratings, housing volume, spare keys, switches, relays, annunciator modules, terminals, and cable conductor quantities adequate to increase the number of stations in the future by 25 percent above those indicated without adding internal or external components or main trunk cable conductors.
4. Existing System Compatibility: Functionally and electrically compatible with existing system so components and wiring operate as an extension or upgrade of the existing system and existing or upgraded functional performance of the existing system applies to the entire final system. Colors, tones, types, and durations of signal manifestation shall be common among new and existing systems.
5. Resistance to Electrostatic Discharge: System, components, and cabling, and the selection, arrangement, and connection of materials and circuits, shall be protected against damage or diminished performance when subjected to electrostatic discharges of up to 25,000 V in an environment with a relative humidity of 20 percent or less.
6. Equipment: Microprocessor, electronic, modular.
7. Master Nurse-Call Station: Programmed via a PC.
8. Wall-Mounted Component Connection Method: Components connect to system wiring in back boxes with factory-wired plug connectors.
9. Telephone Interface: Permit use of wired and wireless telephones to execute nurse-call master station functions.
10. Third-Party Pager Interface: Programmable to send tone, numeric, and alphanumeric message to pocket pagers or personal digital assistants and to use industry standard-protocol, RS-485 interface.

B. Visual/Tone Nurse-Call System

1. Operational Requirements:
 - a. Patient Station Call: Lights a steady call-placed lamp on the station, steady lamps in the zone light and corridor dome light associated with the patient's room, and steady lamps at the central annunciator and other system display devices and displays message on master and staff/duty stations. At the same time, it sounds a programmed tone at intervals, at the respective annunciator and master and staff/duty stations. Legends at the central annunciator and master station identify the calling station.
 - b. Pull-Cord-Call Station Call: Flashes a call-placed lamp on the station and distinctive-color lamps in the zone light and corridor dome light and at the central annunciator and staff/duty stations. At the same time, it sounds a programmed tone at intervals, at the central annunciator and master and staff/duty stations. A legend at the master station identifies the calling station, priority as programmed, and bed identification.
 - c. Emergency-Call Station Call: Produces the same responses as pull-cord-call station calls except rapidly flashing red emergency digital display and tone repetition rates are more frequent, tone frequency is higher, and lamps in the zone light and corridor dome light are a different color. Indicator lamps may be extinguished and the system reset only at the calling station. Displays message on pocket pagers, sounds programmed tone on phones, and displays message on display equipped phones.
 - d. System Reset: Operating reset button at the originating station cancels signals associated with the call. Illuminates a green digital display on the patient station and log presence on the master station.
 - e. Cord-Set Removal: Initiates a patient station call when the cord set is removed from the jack in the patient station faceplate. Displays location and "cord removed" message on master station, pocket pagers, and display equipped phones. Inserting a cord-set plug or a dummy plug into the jack and operating the station reset button resets the call.
 - f. Patient Control Unit: Controls entertainment volume and channel selection. Nurse button on the unit initiates a patient station call. Integral speaker reproduces entertainment sound.
 - g. Emergency Bath Station Call: Illuminates the digital display on the emergency bath station; rapidly flashes white dome lamp; displays location, priority, and bath on master

- station; and sounds programmed tone on master station display equipped phones and pocket pagers.
- h. Staff/Duty Station Operation: Operation shall be identified to patient station except the message staff shall display on all devices when the staff call button is activated.
- i. Privacy Key Activation: When privacy key is activated on patient station, the system shall disconnect the patient station microphone and slowly flash yellow privacy digital display on the patient station. Displays "privacy" on master station when selecting this room/bed.
- 2. Central Annunciator:
 - a. Lamp type.
 - b. Lamp Legends: Machine lettered and legible from a distance of at least **48 inches (1200 mm)** when a call is present. Legend shall identify initiating station and priority of call.
 - c. Power-on Indicator: Digital, or push-to-test switch.
 - d. Audible Signal: Electronic tone.
- 3. Central Equipment Cabinet:
 - a. Lockable metal.
 - b. Houses power supplies, controls, terminal strips, and other components.
 - c. Power-on indicator lamp.
 - d. Battery Backup Unit: Sealed nickel-cadmium, wet-cell battery supplies power through an automatic switch when normal power fails, for a period of not less than six minutes at rated output. System shall lose no unanswered calls or calls in progress during the transfer operation.
 - 1) Automatic retransfer to normal power, after a 15-minute time delay.
 - 2) Two-rate battery charger with an automatic trickle rate and a recharge rate.
- 4. Single-Patient Station: Call-placed lamp, reset push button, and polarized receptacle matching cord-set plug; mounted in a single faceplate.
- 5. Dual-Patient Station: Single call-placed lamp, single reset push button, and two polarized receptacles matching cord-set plug; mounted in a single faceplate.
- 6. Ambulatory-Patient Station: Call push-button switch, call-placed lamp, and reset push button; mounted in a single faceplate.
- 7. Staff/Duty Stations: A minimum of two call lamps, one for routine calls and one for emergency calls; and an audible tone signal device.
- C. Audiovisual/Voice Nurse-Call System
 - 1. Operational Requirements:
 - a. Station Selection from Master Station: Capable of selectively communicating with other stations or groups of stations on its system by touch screen, mouse click, or manual switch; and capable of programming up to 256 stations for each master station in the network.
 - b. Master Station Privacy: Capable of conversing with individual stations in complete privacy.
 - c. Called Station:
 - 1) Capable of hands-free and two-way conversation.
 - 2) Pressing "talk/listen" key shall cause the annunciation tone to cease.
 - 3) Pressing "cancel" key terminates normal calls and conversations.
 - 4) Terminating of high-priority level 1 **OR 2 OR 3 OR 4, as directed**, shall not be allowed except at calling station location and shall send "remind" message if the call is not acknowledged at point of origin in programmed time frame.
 - d. Annunciation:
 - 1) At the master station, a programmable tone announces an incoming call; an annunciator light or digital display identifies the calling station and indicates the priority of the call.
 - 2) Call type indications include alarm assist, bath, bed, code, communication fault, cord out, door, emergency, and fire.
 - 3) Memory lamps or lighted displays identify stations selected for outgoing calls.
 - e. System Reset at Master Station: A normal, incoming call can be canceled, associated lights and audible tones extinguished, and the system reset when the station switch is returned to the normal position.

- f. Patient Station Calls:
 - 1) Lights the call-placed lamp at patient station, zone, and corridor dome lights.
 - 2) Sounds a tone and lights the call lights at staff/duty stations and actuates annunciation at the master station.
 - 3) When the calling station is selected at the master station, the patient can converse with the master station without moving and without raising or directing the voice.
 - 4) During voice communications, entertainment audio at the calling station is automatically muted.
- g. Pull-Cord-Call Station Calls and Emergency-Call Station Calls:
 - 1) Lights call-placed lamp and corridor dome light and flashes zone light.
 - 2) Master station tone pulses and annunciator light for that room flashes.
 - 3) When master station acknowledges the call by touch screen or switch, the tone stops but lights continue to flash until the call is canceled at the initiating point.
- h. Code Blue and Staff/Duty Station Calls:
 - 1) Lights the call-placed lamp at the station and actuates annunciation at the master station.
 - 2) When the called station is selected at the master station, the caller and the master station operator can converse.
 - 3) Code Blue: Unique sound and light pattern indicating the highest priority emergency.
 - 4) Staff Station: Unique sound and light pattern indicating an emergency.
 - 5) Duty Station: Sound and light pattern indicating a call to the nurse station.
- i. Handset Operation: Lifting the handset on master station disconnects speaker/microphone and transfers conversation to the handset.
- j. Station Privacy: No patient or staff/duty station can be remotely monitored without lighting a warning lamp at the monitored station.
- k. Patient Station Cord-Set Removal:
 - 1) A patient station call is initiated as described above when a patient station cord-set plug is removed from the jack in the station faceplate.
 - 2) Tone stops but lights continue to flash until the call is canceled at the initiating point or the plug is reinserted or replaced with a dummy plug when the master station call button for the station is pressed.
- l. Patient Control Unit:
 - 1) Controls entertainment volume and channel selection.
 - 2) Speaker is used for both nurse communication and entertainment sound.
 - 3) Entertainment sound is automatically muted when station is communicating with master station.
 - 4) Nurse button on the unit initiates a patient station call.
- m. Selective Paging: Master station is capable of initiating a message to selected groups of stations or speakers simultaneously by using station group switches.
- n. Staff Reminder:
 - 1) Master station can initiate a staff reminder that a patient requires direct staff response by operating a reminder control while in contact with the patient station.
 - 2) This reminder will light a distinctive-color lamp in the corridor dome light at the patient's room and in the appropriate zone lights.
 - 3) Reminder calls are canceled by operating a staff reminder cancel switch in the patient's room.
- o. Call Priority Indication:
 - 1) Capable of eight call priority levels in addition to normal.
 - 2) Call priority switch near each patient station, or integral with the master station, shall control priority status of the call transmitted by individual stations.
 - 3) Switch selects one of the following status levels:
 - a) Normal: No change to the normal call initiation and canceling sequence.

- b) Emergency: Call initiation produces signals and indications identical to those of emergency-call stations. Indicator lamps are extinguished and the system is reset only at the originating station.
- c) Priority: System response is the same for emergency status except voice communication between the master station and the calling station is locked in from the time of call initiation until the system is reset at the originating station.
- p. Additional Call:
 - 1) Waiting display window on the master station similar to current call window displays incoming calls.
 - 2) Master station shall have a call-overflow indicator when incoming calls exceed **<Insert number>** calls.
 - 3) System shall store unlimited number of incoming calls.
 - 4) System shall be capable of automatically answering incoming calls in order of priority.
- q. Calling Intercom Stations:
 - 1) Master station shall be capable of calling any intercom station using the handset or the hands-free speaker/microphone.
 - 2) Receipt of a call at the intercom station shall be preceded by an optional pre-announce tone.
 - 3) If there is a call in process, system shall place the active call on automatic hold while the new call is placed, then reestablish the previous call when the new call has ended.
- r. Privacy Override:
 - 1) Temporarily deactivates the "Privacy" mode of a called station by calling the station and instructing the called party to press the call-cord button.
 - 2) On completion of the conversation, the called station shall automatically return to the "Privacy" mode.
 - 3) When in "Privacy" mode, a called station shall be capable of hearing the master station; however, the master station shall not be capable of hearing the called station; a privacy message shall be indicated on the master station display.
- s. Master-Station-to-Master-Station Calls:
 - 1) Master stations shall be capable of calling other master stations using the handset.
 - 2) Calls from master stations shall be answered using the handset only.
 - 3) Busy master stations shall be indicated by a master station intercom busy tone.
- t. Voice Paging:
 - 1) Capable of voice paging to all stations using a single "All Call" key. The page shall be preceded by an optional pre-announce tone, **as directed**.
 - 2) Capable of voice paging to eight user-defined groups of stations by selecting the group and then the "All Call" key. The page shall be preceded by a pre-announce tone, **as directed**.
 - 3) Capable of voice paging to all staff/duty stations and all patient stations where staff has registered presence using a single "Public Address (PA)/Staff" key. The page shall be preceded by a pre-announce tone, **as directed**.
 - 4) Capable of voice paging through a third-party PA system.
 - 5) Capable of including or excluding any station from the voice paging function(s).
 - 6) Automatically places an active station call on hold during any page and reestablishes the connection at the end of the page.
 - 7) Automatically cancels a page if the talk mode is inactive for more than 15 seconds.
- u. Station Monitor:
 - 1) An audio monitor feature shall allow a user to sequentially or simultaneously listen to one or all stations that are included in the user-created list.
 - 2) Master station display shall indicate which station is being monitored when in sequential mode.
 - 3) The dwell time each station is monitored shall be user programmable.
 - 4) The user shall be able to stop the monitoring sequence by activating a "pause" key.

- 5) The user shall be able to manually sequence through stations using a "next" key.
- v. Night Service:
 - 1) Functions shall be adaptable for nighttime staffing levels, patient traffic, and day/night operations.
 - 2) Staff Follow:
 - a) Capable of locating roving staff; forwarding visual and audible annunciation of incoming calls to station(s) where personnel have registered presence.
 - b) Master station shall display locations where staff have registered presence.
 - c) Incorporates a programmable timer that automatically cancels a forgotten staff presence registration.
 - 3) Tones:
 - a) Deactivates audio signals from a duty station and mini-master display telephones.
 - b) Capable of changing the tone volume at the master and duty stations.
 - c) Satellite function shall permit the user to deactivate audio signals from duty stations and other remote annunciator devices.
 - 4) Transfer:
 - a) Permits one nurse station to take control of all or individually selected bed call cords from another nurse station. It shall be possible to view transfer status of a nurse station.
 - b) Includes a minimum of three transfer modes to allow one nurse station to take control or share calls and operations from another nurse station.
 - i. Parallel Transfer Mode: Permits both nurse stations to share all calls and operations.
 - ii. Supervised Transfer Mode: Permits the transferred nurse station to share all calls and operations with the controlling nurse station; however, the controlling nurse station calls are not shared with the transferring station.
 - iii. Capture Transfer Mode: Transfers all calls and operations from the transferred nurse station to the controlling nurse station.
 - iv. Transferred station shall have no control over calls, and its display shall indicate calls have been transferred to another station.
 - c) Includes two "patient swing" modes to allow one nurse station to take control or share calls from one or many calls from another nurse station.
 - i. Supervised Transfer Mode: Permits the transferred calls to be shared with the controlling nurse station.
 - ii. Capture Transfer Mode: Transfers all calls from the call cord from the transferred nurse station to the controlling nurse station.
 - iii. Transferred station has no control over those transferred calls.
- w. Service Request:
 - 1) Permits users to assign a service request to a substation, at programmable priority level.
 - 2) Displays service request on the nurse station display and light the green flashing corridor lamp at the respective substation and automatically generate a service reminder request.
 - 3) Cancels service requests only at the initiating point.
 - 4) Recall calls shall sound and be displayed at the master station if the service request has not been cancelled at the initiating point within the programmed period of time.
- x. Call Reminder Function:
 - 1) Automatically generates a reminder call for a patient- or staff-initiated, high-priority 2 **OR 3 OR 4, as directed**, request that has had the call tones silenced, allowing time to physically attend to the request and cancel the call at the initiating point.
 - 2) Regenerated calls shall display the same tones and visual indications and priority as the original call and shall also display a "regenerated call" message.
 - 3) Capable of manually adding low-priority calls to the reminder list.

- 4) "Call Reminder" function and reminder timer shall be programmable by call priority.
 - y. Hide Function: Prevents a selected station from displaying calls or generating tones on the nurse station.
 - z. Door Control Function: Capable of being programmed to enable the user to remotely activate electric door locks.
 - aa. Test and Diagnostics Feature:
 - 1) Able to automatically diagnose system faults and categorize them as warnings, communication errors, or fatal errors.
 - 2) Warnings shall indicate possible system problems.
 - 3) Communication errors shall indicate the inability of the master station to communicate with a substation or another nurse-call station.
 - 4) Fatal errors shall indicate a major hardware or software failure.
 - bb. User-Configured System Programming - Access Code Not Required:
 - 1) Patient call-cord priority levels.
 - 2) Monitor list.
 - 3) "All Call" list.
 - 4) Master station communication parameters (volume, filtering, talk/listen, sensitivity).
 - 5) Master and duty station call annunciation tone volume.
 - 6) Date/time.
 - 7) Staff-follow operating mode.
 - 8) Transfer type.
 - 9) Pocket pager list assignment.
 - 10) Presence mode.
 - cc. User-Configured System Programming - Access Code Required:
 - 1) Master station number.
 - 2) Room device type.
 - 3) Room number.
 - 4) Bed number.
 - 5) Bed alpha or numeric.
 - 6) Reminder duration.
 - 7) Staff presence registration cancel duration.
 - 8) Display language.
 - 9) Paging group assignment(s).
 - 10) Zone group assignments.
 - 11) Monitoring duration.
 - 12) Pocket pager number.
 - 13) Call tone assignment by priority.
 - 14) Pretone activation.
 - 15) Call tones minimum volume.
 - 16) Clock mode (12 h/24 h).
2. Master Station:
- a. Speaker/microphone unit with operating controls.
 - b. Indicator lamps with legends or by digital display designate identification and priority of calling stations and called stations.
 - c. Pulse rate of incoming-call lights denotes priority of calls awaiting response.
 - d. Station Selection Controls: Touchpad select stations for two-way voice communications.
 - e. Signal Tones: Programmable to announce incoming calls.
 - f. Pulse rate and frequency of tone identify the highest priority call awaiting response at one time.
 - g. Volume Control: Regulates incoming-call volume.
 - h. Privacy Handset with Hook Switch: Of the type that does not require push-to-talk switch attached to each station unless otherwise indicated.
 - i. Staff Reminder Control: Initiates flashing of corresponding corridor dome lights for patients requiring service. Permits scanning equipment to indicate which patients are currently in reminder status.

- j. Call Priority Selection: Controls associated with patient-station selection switches determine the priority displayed when a call is initiated at a patient station.
- 3. Central Equipment Cabinet:
 - a. Lockable metal.
 - b. Houses amplifiers, tone generators, power supplies, controls, terminal strips, and other components.
 - c. Amplifier: With fidelity and overall gain necessary to achieve the sound-transmission and reproduction characteristics specified, considering interoperability with the installed speakers/microphones and wiring.
 - 1) Power Output: Not less than 3 W at a total harmonic distortion not exceeding 5 percent.
 - 2) Hum and Noise: 60 dB below full output with normal input open.
 - 3) Volume Control: Concealed within the amplifier unit to control the volume of sound reproduced at all stations.
 - 4) Protection: Circuit to prevent damage to the amplifier in case of shorted or open circuit.
 - d. Selective Paging Amplifiers: Plug-in card mounted in central equipment cabinet, rated 15 W.
 - e. System Power Supply:
 - 1) 24-V dc for operation of the call system.
 - 2) Equipment Rating: Suitable for continuous operation between 32 and 120 deg F (0 and 49 deg C), from a primary line voltage between 105- to 125-V ac, 60 Hz.
 - 3) Output: Regulated 24-V dc with protection against overloads. Line-to-load regulation shall not exceed 2-1/2 percent with ripple and noise remaining below the 10-mV, rms level.
 - 4) Overload Protection: Electronic fold-back circuit set to limit the volt-ampere output to less than 100 VA during overloaded or shorted output. Restore power output automatically on removal of overload without resetting circuit breakers or replacing fuses.
 - f. Power-on indicator lamp.
 - g. Surge Protector Device: Comply with Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits" for auxiliary panel suppressors, with digital indicator lights for power and protection status.
 - h. Battery Backup Unit: Sealed nickel-cadmium, wet-cell battery supplies power through an automatic switch when normal power fails, for a period of not less than six minutes at rated output.
 - 1) Automatic retransfer to normal power, after a 15-minute time delay.
 - 2) Two-rate battery charger with an automatic trickle rate and a recharge rate.
- 4. Speaker/Microphones:
 - a. Type: Permanent-magnet, dynamic or ceramic, protected against dust and humidity.
 - b. Sound Reproduction: Sound level of 90 dB plus or minus 3 dB at a distance of 48 inches (1220 mm) on the axis without overdriving or distorting any frequencies between 300 and 3000 Hz when installed in an enclosure or in the pillow speaker.
 - c. Power Handling Capacity: Not susceptible to damage from overdriving within the range of power available from the amplifier.
 - d. Impedance Matching: Coordinated and matched to the input and output circuits of the amplifier, both for single connection and for group monitoring, to provide the sound reproduction specified. Subsystems or components shall not be combined, which could cause unacceptable distortion such as feedback between pillow speakers and unmuted room speaker/microphone combinations. This protection shall extend throughout the entire range of operation (volume control) of all components.
- 5. Single-Patient Station: Speaker/microphone with 2-inch (50-mm) dynamic cone, a polarized receptacle to match the cord-set plug, monitor lamp, reset switch, and call-placed lamp; assembled under a single faceplate.
- 6. Dual-Patient Station:

- a. Speaker/microphone with 2-inch (50-mm) dynamic cone, two polarized receptacles to match cord-set plugs, monitor lamp, and reset switch; assembled under a single faceplate.
 - b. Single call-placed lamp serves both beds.
OR
Dual call-placed lamps, one for each bed.
 7. Staff/Duty Stations: Audible call-tone signal device, speaker/microphone with 2-inch (50-mm) dynamic cone, monitor lamp, reset switch, routine-call lamp, emergency-call lamp, and call push button; assembled under a single faceplate.
 8. Code Blue Station: Audible call-tone signal device, speaker/microphone with 2-inch (50-mm) dynamic cone, monitor lamp, reset switch, Code Blue emergency-call lamp, and call push button; assembled under a single faceplate.
 9. Ambulatory-Patient Station: Speaker/microphone with 2-inch (50-mm) dynamic cone, monitor lamp, reset switch, call-placed lamp, and call push button; assembled under a single faceplate.
 10. Selective Paging Speakers: 8-inch (200-mm) cone type with 1-inch (25-mm) voice coil and minimum 5-oz. (140-g) ceramic magnet, multitap matching transformer, flush-mounted steel back-box, and white enamel-finished metal ceiling grille.
 11. Call Priority Switch Station: Three-position, tamper-resistant priority selection switch. Positions designated by labeling "Normal," "Emergency," and "Priority."
 12. Staff Reminder Cancel Switch Station: Momentary contact.
- D. System Components
1. Emergency-Call Station: Locking-type push button, labeled "Push to Call Help"; reset trigger to release push button and cancel call; and call-placed lamp, mounted in a single faceplate.
 2. Emergency-Bath Station:
 - a. Consists of a sliding, chemical-resistant, ABS red fascia marked with the word "URGENT" in bold letters.
 - b. Capable of being activated with nylon pull cord or by sliding the face of the unit downwards.
 - c. Activation of the station shall illuminate a reassurance digital display on the face of the unit in addition to notifying the master station.
 - d. Water resistant and able to withstand routine cleaning and chemical disinfectants.
 - e. Uses magnetic reed switch technology for reliability and corrosion resistance.
 - f. Mounts on a single-gang electrical box wire to the respective patient station or input controller.
 3. Code Blue Station:
 - a. Consists of a sliding, chemical-resistant, ABS blue fascia marked with the word "CODE" in bold letters.
 - b. Capable of being activated with nylon pull cord or by sliding the face of the unit downwards.
 - c. Activation of the station shall illuminate a reassurance digital display on the face of the unit in addition to notifying the master station.
 - d. Water resistant and able to withstand routine cleaning and chemical disinfectants.
 - e. Uses magnetic reed switch technology for reliability and corrosion resistance.
 - f. Mounts on a single-gang electrical box wire to the respective patient station or input controller.
 4. Staff, Emergency Station:
 - a. Consists of a sliding, chemical-resistant, ABS red fascia marked with the word "EMERGENCY" in bold letters.
 - b. Capable of being activated with nylon pull cord or by sliding the face of the unit downwards.
 - c. Activation of the station shall illuminate a reassurance digital display on the face of the unit in addition to notifying the master station.
 - d. Mounts on a single-gang electrical box wire to the input controller.
 5. Pull-Cord-Call Station:
 - a. Pull-Down Switch: Lever-locking type, labeled "Pull Down to Call Help."
 - b. Reset trigger.

- c. Call-placed lamp.
- d. Water-resistant construction.
- 6. Patient Control Unit:
 - a. Equipped with plug and 96-inch- (2400-mm-) long white cord.
 - b. Ethylene oxide, sterilizable.
 - c. Light-Control Switch: Arranged for independent on-off control of patient's up and down light.
 - d. Integral Speaker: 2 inches (50 mm), with 0.35-oz. (9.9-g) magnet, rated 0.2 W.
 - e. Controls: Speaker volume, TV control, and nurse call.
 - f. Housing: High-impact white plastic.
 - g. Attachment: Stainless-steel bed clamp with permanently attached polyester film strap.
 - h. Quantity: 12 units for every 10 patient beds.
- 7. Call-Button Cord Set:
 - a. Plug and 72-inch (1800-mm) white cord; cord set shall be resistant to medical gas environment equipped with momentary-action, call-button switch.
 - b. Ethylene oxide, sterilizable.
 - c. Washable cord.
 - d. Palladium switch contacts in high-impact white housing with cord-set strain relief.
 - e. Attachment: Stainless-steel bed clamp with permanently attached polyester film strap.
 - f. Quantity: Three cord sets for every 10 patient beds.
- 8. Geriatric Call-Button Cord Set:
 - a. Plug and 72-inch (1800-mm) white cord.
 - b. Resistant to medical gas environment equipped with momentary-action, light-pressure switch in soft outer jacket.
 - c. Ethylene oxide, sterilizable.
 - d. Washable cord.
 - e. Palladium switch contacts in high-impact white housing with cord-set strain relief.
 - f. Attachment: Stainless-steel bed clamp with permanently attached polyester film strap.
 - g. Quantity: Two cord sets for every 10 patient beds.
- 9. Squeeze-Bulb Switch Cord Set:
 - a. Plug and 72-inch (1800-mm) washable tube with white cord set.
 - b. Resistant to medical gas environment; washable; equipped with neoprene squeeze-bulb activator, and plug-mounted, momentary contact switch.
 - c. Ethylene oxide, sterilizable.
 - d. Attachment: Stainless-steel bed clamp with permanently attached polyester film strap.
 - e. Quantity: Two cord sets for every 10 patient beds.
- 10. Breath Call Cord:
 - a. Flexible PVC jacketed cable and a momentary contact air-pressure sensitive switch.
 - b. Cord: 108 inches (2700 mm) long.
 - c. Include an adjustable arm for clamping and suitable for use in oxygen atmospheres.
 - d. Include 12 replacement straws.
- 11. Pillow Speakers:
 - a. Eight-conductor, DIN, flexible PVC jacketed cable.
 - b. Contain nurse-call button, volume control, speaker, and channel control in molded flame-retardant ABS housing.
 - c. Cord: 96 inches (2400 mm) long with sheet clip.
- 12. Call-Button Plug:
 - a. Designed to plug into patient station cord-set receptacle.
 - b. Button switches call circuit.
 - c. Two plugs for every 10 patient beds.
- 13. Dummy Plugs:
 - a. Designed to plug into patient station cord-set receptacle when call-button plug or patient cord set is not used.
 - b. Three plugs for every 10 patient beds.
- 14. Indicator Lamps: Digital type with rated life of 20 years unless otherwise indicated.

15. Station Faceplates:
 - a. Stainless steel, a minimum of 0.0375 inch (0.95 mm) thick.
 - b. Finish: Brushed.
 - c. Machine-engraved labeling identifies indicator lamps and controls.

OR

Station Faceplates:

 - a. High-impact plastic.
 - b. Color: Beige.
 - c. Molded or machine-engraved labeling identifies indicator lamps and controls.
16. Corridor Dome Lights and Zone Lights:
 - a. Three-lamp signal lights.
 - b. Lamps: Front replaceable without tools, low voltage with rated life of 7500 hours. Barriers are such that only one color is displayed at a time.
 - c. Lenses: Heat-resistant, shatterproof, translucent polymer that will not deform, discolor, or craze when exposed to hospital cleaning agents.
 - d. Filters: Two per unit, amber and red.
17. Cable:
 - a. Conductors: Jacketed single and multiple, twisted-pair copper cables.
 - b. Sizes and Types: As recommended by equipment manufacturer.
 - c. Cable for Use in Plenums: Listed and labeled for plenum installation.
18. Grounding Components: Comply with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".

E. Software Requirements

1. Telephone System Interface:
 - a. Permits use of wired and/or wireless telephones to execute nurse-call master station.
 - b. Two-way communication with patient and staff stations.
 - c. Two-way communication with the master nurse station.
 - d. "All Call," group call, and staff call paging.
 - e. Capable of being programmed to forward calls destined for a master nurse station to any connected telephone.
 - f. Telephones connected to the telephone interface shall have the same call tone ring patterns as those generated at the master nurse station.
 - g. Telephones having a display shall indicate the call type, priority code, and the calling station number of incoming calls.
 - h. Telephones shall be capable of initiating a service request for a particular patient station, logging calls on the master station's reminder list, and activating door lock mechanisms associated with a call station.
 - i. Capable of routine setup and configuration changes using the keypads on display telephone and/or the master station.
2. Display Telephones:
 - a. Digital telephones for use as mini-master nurse-call stations.
 - b. Digital display shall indicate the call type, priority code, and calling station number of incoming calls.
 - c. Ring patterns shall be identical to those generated at the master station.
 - d. Capable of two-way communication with patient and staff stations and the master station, and other telephones interfaced with the system.
 - e. Capable of placing or answering outside calls when interfaced with the facility telephone system.
 - f. Capable of "All Call," group call, and staff call paging and of initiating service requests, logging calls to the reminder list, and activating optional door controls.
3. Third-Party Pocket Pager Interface:
 - a. Equipped with a standalone pocket pager interface.
 - b. Connects with the facility paging system and transmit alphanumeric messages to the pocket pagers as preprogrammed in the system.
4. Statistical Software:

- a. Includes a data statistical software package that stores, sorts, and analyzes activities occurring on the nurse-call system network.
- b. Windows based and operated on a PC that is connected to the nurse-call system network.
- c. Stores events on the PC's hard disk. Accumulation of these stored events shall make up the database that is used to generate reports and statistics.
- d. Events stored by the software shall include date, day of week, time, ward, priority, and room number.
- e. Capable of assigning a patient name to bed number.
- f. Stored events shall include, but not be limited to, calls placed, call priority, calls cancelled at the nurse station, calls cancelled at the point of origin, regenerated calls, calls answered, calls sent to pager interface, staff presence registration, staff presence cancellation, service request, service cancellation, and system and network error messages.
- 5. Data Analysis Software:
 - a. Capable of analyzing the stored information and generating computed analysis.
 - b. Analysis of the database can be conducted by specifying one, many, or all of the following parameters of the database: date, day of week, time, wards, priority, and room number.
 - c. Analysis shall include, but not be limited to, total number of calls placed, average call response time (from call placed to call cancellation), total number of presence registrations, average presence time in a room, total number of service requests, average response time (from audio answer to call cancellation), and average ring time (from call placed to audio answer).
- 6. Statistical Software Package:
 - a. Capable of displaying multiple calls/events on a PC monitor or on a RS-485 data-bus-driven digital display panel.
 - b. Calls from patient or staff stations and associated devices shall be displayed by priority. Display shall be customizable as follows:
 - 1) Choice of color by type of call.
 - 2) Choice of display size (character size).
 - 3) Choice of priority levels, type of events, points of origin.
 - 4) Identification of facility.
 - 5) Identification of ward.
 - 6) Identification of patient with specific patient information.

F. Conductors And Cables

- 1. Audio Cables:
 - a. Conductors: Jacketed, twisted-pair and twisted-multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.
 - b. Insulation: Thermoplastic, not less than **1/32 inch (0.8 mm)** thick.
 - c. Shielding: For speaker/microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil.
 - d. Minimum Shielding Coverage on Conductors: 60 percent.
 - e. Plenum Cable: Listed and labeled for plenum installation.
- 2. Data Cable and Hardware: Category 5e **OR** Category 6, **as directed**, UTP and UTP hardware. Comply with requirements in Division 27 Section "Communications Horizontal Cabling".
- 3. Power Conductors and Cables: Copper, solid, No. 20 AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
- 4. Grounding Conductors and Cables: Copper, stranded, No. 16 AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

1.3 EXECUTION

A. Installation

- 1. Wiring Method:

- a. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used, **as directed**.
 - 1) Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2) Conceal raceway and cables except in unfinished spaces.
 - b. Cable Trays: Comply with requirements in Division 27 Section "Communications Horizontal Cabling".
 - c. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems". Flexible metal conduit shall not be used, **as directed**.
 - 1) Outlet boxes shall be no smaller than **2 inches (50 mm)** wide, **3 inches (75 mm)** high, and **2-1/2 inches (64 mm)** deep.
 2. Install cables without damaging conductors, shield, or jacket.
 3. Do not bend cables, while handling or installing, to radii smaller than as recommended by manufacturer.
 4. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
 - a. Pull cables simultaneously if more than one is being installed in same raceway.
 - b. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
 - c. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.
 5. Install exposed raceways and cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by straps, staples, or similar fittings designed and installed so as not to damage cables. Secure cable at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, or fittings.
 6. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
 7. Separation of Wires: Separate speaker/microphone, line-level, speaker-level, and power-wiring runs. Run in separate raceways or, if exposed or in same enclosure, provide **12-inch (300-mm)** minimum separation between conductors to speaker/microphones and adjacent parallel power and telephone wiring. Provide separation as recommended by equipment manufacturer for other conductors.
 8. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Install terminal cabinets where there are splices, taps, or terminations for eight or more conductors.
 9. Impedance and Level Matching: Carefully match input and output impedances and signal levels at signal interfaces. Provide matching networks if required.
 10. Identification of Conductors and Cables: Comply with requirements in Division 27 Section "Communications Horizontal Cabling" for cable administration, cable schedule, and cable and wire identification.
 11. Equipment Identification:
 - a. Comply with requirements in Division 26 Section "Identification For Electrical Systems" for equipment labels and signs and labeling installation requirements.
 - b. Label stations, controls, and indications using approved consistent nomenclature.
- B. Existing Systems
1. Examine existing systems for proper operation, compatibility with new equipment, and deficiencies. If discrepancies or impairments to successful connection and operation of interconnected equipment are found, report them and do not proceed with installation until directed. Schedule existing systems' examination so there is reasonable time to resolve problems without delaying construction.
- C. Grounding
1. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other signal impairments.

2. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding except at connection to main building ground bus.
3. Grounding Provisions: Comply with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".

D. Field Quality Control

1. Perform tests and inspections.
2. Tests and Inspections:
 - a. Schedule tests a minimum of seven days in advance.
 - b. Report: Submit a written record of test results.
 - c. Operational Test: Perform an operational system test and demonstrate proper operations, adjustment, and sensitivity of each station. Perform tests that include originating station-to-station and "All Call" messages and pages at each nurse-call station. Verify proper routing, volume levels, and freedom from noise and distortion. Test each available message path from each station on the system. Meet the following criteria:
 - 1) Speaker Output: 90 dB plus or minus 3 dB, 300 to 3000 Hz, reference level threshold of audibility 0 dB at 0.02 mPa of sound pressure.
 - 2) Gain from patient's bedside station to nurse station, with distortion less than 65 dB (plus or minus 3 dB, 300 to 3000 Hz).
 - 3) Signal-to-Noise Ratio: Hum and noise level at least 45 dB below full output.
 - d. Test Procedure:
 - 1) Frequency Response: Determine frequency response of two transmission paths by transmitting and recording audio tones.
 - 2) Signal-to-Noise Ratio: Measure the ratio of signal to noise of the complete system at normal gain settings using the following procedure: Disconnect a speaker/microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure the ratio of signal to noise and repeat the test for four speaker microphones.
 - 3) Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 300, 400, 1000, and 3000 Hz into each nurse-call equipment amplifier, and measure the distortion in the amplifier output.
3. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify, by the system test, that the total system meets these Specifications and complies with applicable standards. Report results in writing.
4. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
5. Prepare test and inspection reports.

E. Adjusting

1. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting sound levels and controls to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal operating hours for this purpose.

F. Demonstration

1. Train Owner's maintenance personnel and caregiver staff to adjust, operate, and maintain nurse-call equipment.

END OF SECTION 26 33 43 00a

SECTION 26 33 43 00b - PUBLIC ADDRESS AND MASS NOTIFICATION SYSTEMS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of public address and mass notification 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. Section Includes:
 - a. Preamplifiers.
 - b. Power amplifiers.
 - c. Transfer to standby amplifier.
 - d. Microphones.
 - e. Volume limiter/compressors.
 - f. Control console.
 - g. Equipment cabinet.
 - h. Equipment rack.
 - i. Telephone paging adapters.
 - j. Tone generator.
 - k. Monitor panel.
 - l. Loudspeakers.
 - m. Noise-operated gain controllers.
 - n. Microphone and headphone outlets.
 - o. Battery backup power unit.
 - p. Conductors and cables.
 - q. Raceways.

C. Definitions

1. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.
2. VU: Volume unit.
3. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

D. Performance Requirements

1. Delegated Design: Design supports and seismic restraints for control consoles, equipment cabinets and racks, and components, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Seismic Performance: Supports and seismic restraints for control consoles, equipment cabinets and racks, and components 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 and the unit will be fully operational after the seismic event."

E. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: For supports and seismic restraints for control consoles, equipment cabinets and racks, and components. Include plans, elevations, sections, details, and attachments to other work.

- a. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
 - b. Console layouts.
 - c. Control panels.
 - d. Rack arrangements.
 - e. Calculations: For sizing backup battery.
 - f. Wiring Diagrams: For power, signal, and control wiring.
 - 1) Identify terminals to facilitate installation, operation, and maintenance.
 - 2) Single-line diagram showing interconnection of components.
 - 3) Cabling diagram showing cable routing.
 3. Delegated-Design Submittal: For supports and seismic restraints for control consoles, equipment cabinets and racks, and components 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 supports and seismic restraints for control consoles, equipment cabinets and racks, and components.
 4. Seismic Qualification Certificates: For control consoles, equipment cabinets and racks, 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.
 5. Field quality-control reports.
 6. Operation and maintenance data.
- F. 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. Functional Description Of System

1. System Functions:
 - a. Selectively connect any zone to any available signal channel.
 - b. Selectively control sound from microphone outlets and other inputs.
 - c. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
 - d. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
 - e. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
 - f. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of non-uniform coverage of amplified sound.

B. General Equipment And Material Requirements

1. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
2. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

3. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a **19-inch (483-mm)** housing complying with TIA/EIA-310-D.
 4. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.
- C. Preamplifiers
1. Preamplifier: Separately mounted.
 2. Preamplifier: Integral to power amplifier.
 3. Output Power: Plus 4 dB above 1 mW at matched power-amplifier load.
 4. Total Harmonic Distortion: Less than 1 percent.
 5. Frequency Response: Within plus or minus 2 dB from 20 to 20,000 Hz.
 6. Input Jacks: Minimum of two. One matched for low-impedance microphone; the other matchable to cassette deck, CD player, or radio tuner signals without external adapters.
 7. Minimum Noise Level: Minus 55 dB below rated output.
 8. Controls: On-off, input levels, and master gain.
- D. Power Amplifiers
1. Mounting: Console **OR** Rack, **as directed**.
 2. Output Power: 70-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus an allowance for future stations.
 3. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.
 4. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.
 5. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.
 6. Output Regulation: Less than 2 dB from full to no load.
 7. Controls: On-off, input levels, and low-cut filter.
 8. Input Sensitivity: Matched to preamplifier and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.
- E. Transfer To Standby Amplifier
1. Monitoring Circuit and Sensing Relay: Detect reduction in output of power amplifier of 40 percent or more and, in such event, transfer load and signal automatically to standby amplifier.
- F. Microphones
1. Paging Microphone:
 - a. Type: Dynamic, with cardioid **OR** omni, **as directed**, polar characteristic.
 - b. Impedance: 150 ohms.
 - c. Frequency Response: Uniform, 50 to 14,000 Hz.
 - d. Output Level: Minus 58 dB, minimum.
 - e. Finish: Satin chrome.
 - f. Cable: C25J.
 - g. Mounting: Desk stand with integral-locking, press-to-talk switch.
- G. Volume Limiter/Compressor
1. Minimum Performance Requirements:
 - a. Frequency Response: 45 to 15,000 Hz, plus or minus 1 dB minimum.
 - b. Signal Reduction Ratio: At least a 10:1 and 5:1 selectable capability.
 - c. Distortion: 1 percent, maximum.
 - d. Rated Output: Minimum of plus 14 dB.
 - e. Inputs: Minimum of two inputs with variable front-panel gain controls and VU or decibel meter for input adjustment.
 - f. Rack mounting.
- H. Control Console
1. Cabinet: Modular, desktop **OR** desk style, **as directed**; complying with TIA/EIA-310-D.

2. Housing: Steel, **0.0478 inch (1.2 mm)** minimum, with removable front and rear panels. Side panels are removable for interconnecting side-by-side mounting.
 3. Panel for Equipment and Controls: Rack mounted.
 4. Controls:
 - a. Switching devices to select signal sources for distribution channels.
 - b. Program selector switch to select source for each program channel.
 - c. Switching devices to select zones for paging.
 - d. All-call selector switch.
 5. Indicators: A visual annunciation for each distribution channel to indicate source being used.
 6. Self-Contained Power and Control Unit: A single assembly of basic control, electronics, and power supply necessary to accomplish specified functions.
 7. Spare Positions: 20 percent spare zone control and annunciation positions on console.
 8. Microphone jack.
- I. Equipment Cabinet
1. Comply with TIA/EIA-310-D.
 2. House amplifiers and auxiliary equipment at each location.
 3. Cabinet Housing:
 - a. Constructed of **0.0478-inch (1.2-mm)** steel, minimum, with front- and rear-locking doors and standard TIA/EIA-310-D-compliant, **19-inch (483-mm)** racks.
 - b. Arranged for floor or wall mounting as indicated.
 - c. Sized to house all equipment indicated, plus spare capacity.
 - d. Include 20 percent minimum spare capacity for future equipment in addition to space required for future cassette deck and CD player.
 4. Power Provisions: A single switch in cabinet shall disconnect cabinet power distribution system and electrical outlets, which shall be uniformly spaced to accommodate ac-power cords for each item of equipment.
 5. Ventilation: A low-noise fan for forced-air cabinet ventilation. Fan shall be equipped with a filtered input vent and shall be connected to operate from 105- to 130-V ac, 60 Hz; separately fused and switched; arranged to be powered when main cabinet power switch is on.
- J. Equipment Rack
1. Racks: **19 inches (483 mm)** standard, complying with TIA/EIA-310-D.
 2. Power-Supply Connections: Compatible plugs and receptacles.
 3. Enclosure Panels: Ventilated rear and sides and solid top. Use louvers in panels to ensure adequate ventilation.
 4. Finish: Uniform, baked-enamel factory finish over rust-inhibiting primer.
 5. Power-Control Panel: On front of equipment housing, with master power on-off switch and pilot light; and with socket for 5-A cartridge fuse for rack equipment power.
 6. Service Light: At top rear of rack with an adjacent control switch.
 7. Vertical Plug Strip: Grounded receptacles, **12 inches (300 mm)** o.c.; the full height of rack.
 8. Maintenance Receptacles: Duplex convenience outlets supplied independent of vertical plug strip and located in front and bottom rear of rack.
 9. Spare Capacity: 20 percent in rack for future equipment.
- K. Telephone Paging Adapter
1. Adapters shall accept voice signals from telephone extension dialing access and automatically provide amplifier input and program override for preselected zones.
 - a. Minimum Frequency Response: Flat, 200 to 2500 Hz.
 - b. Impedance Matching: Adapter matches telephone line to public address equipment input.
 - c. Rack mounting.
- L. Tone Generator
1. Generator shall provide clock and program interface with public address and mass notification system.

2. Signals: Minimum of seven distinct, audible signal types including wail, warble, high/low, alarm, repeating and single-stroke chimes, and tone.
 3. Pitch Control: Chimes and tone.
 4. Volume Control: All outputs.
 5. Activation-Switch Network: Establishes priority and hierarchy of output signals produced by different activation setups.
 6. Mounting: Rack.
- M. Monitor Panel
1. Monitor power amplifiers.
 2. Components: VU or dB meter, speaker with volume control, and multiple-position rotary selector switch.
 3. Selector Switch and Volume Control: Selective monitoring of output of each separate power amplifier via VU or dB meter and speaker.
 4. Mounting: Rack.
- N. Loudspeakers
1. Cone-Type Loudspeakers:
 - a. Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.
 - b. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
 - c. Size: 8 inches (200 mm) with 1-inch (25-mm) voice coil and minimum 5-oz. (140-g) ceramic magnet.
 - d. Minimum Dispersion Angle: 100 degrees.
 - e. Rated Output Level: 10 W.
 - f. Matching Transformer: Full-power rated with four taps. Maximum insertion loss of 0.5 dB.
 - g. Surface-Mounting Units: Ceiling, wall, or pendant mounting, as indicated, in steel back boxes, acoustically dampened. Front face of at least 0.0478-inch (1.2-mm) steel and whole assembly rust proofed and shop primed for field painting.
 - h. Flush-Ceiling-Mounting Units: In steel back boxes, acoustically dampened. Metal ceiling grille with white baked enamel.
 2. Horn-Type Loudspeakers:
 - a. Type: Single-horn units, double-reentrant design, with minimum full-range power rating of 15 W.
 - b. Matching Transformer: Full-power rated with four standard taps. Maximum insertion loss of 0.5 dB.
 - c. Frequency Response: Within plus or minus 3 dB from 250 to 12,000 Hz.
 - d. Dispersion Angle: 130 by 110 degrees.
 - e. Mounting: Integral bracket.
 - f. Units in Hazardous (Classified) Locations: Listed and labeled for environment in which they are located.
- O. Noise-Operated Gain Controller
1. Gain controller shall be designed to continuously sense space noise level and automatically adjust signal level to local speakers.
 2. Frequency Response: 20 to 20,000 Hz, plus or minus 1 dB.
 3. Level Adjustment Range: 20 dB minimum.
 4. Maximum Distortion: 1 percent.
 5. Control: Permits adjustment of sensing level of device.
- P. Outlets
1. Volume Attenuator Station: Wall-plate-mounted autotransformer type with paging priority feature.
 - a. Wattage Rating: 10 W unless otherwise indicated.
 - b. Attenuation per Step: 3 dB, with positive off position.
 - c. Insertion Loss: 0.4 dB maximum.

- d. Attenuation Bypass Relay: Single pole, double throw. Connected to operate and bypass attenuation when all-call, paging, program signal, or prerecorded message features are used. Relay returns to normal position at end of priority transmission.
- e. Label: "PA Volume."
- 2. Microphone Outlet: Three-pole, polarized, locking-type, microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed outlet covers.
- 3. Headphone Outlet (for the Hearing Impaired): Microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed-outlet covers.

Q. Battery Backup Power Unit

- 1. Unit shall be rack mounted, consisting of time-delay relay, sealed lead-calcium battery, battery charger, on-off switch, "normal" and "emergency" indicating lights, and adequate capacity to supply maximum equipment power requirements for one hour of continuous full operation.
- 2. Unit shall supply public address equipment with 12- to 15-V dc power automatically during an outage of normal 120-V ac power.
- 3. Battery shall be on float charge when not supplying system and to transfer automatically to supply system after three to five seconds of continuous outage of normal power, as sensed by time-delay relay.
- 4. Unit shall automatically retransfer system to normal supply when normal power has been reestablished for three to five seconds continuously.

R. Conductors And Cables

- 1. Jacketed, twisted pair and twisted multipair, untinned solid copper.
 - a. Insulation for Wire in Conduit: Thermoplastic, not less than **1/32 inch (0.8 mm)** thick.
 - b. Microphone Cables: Neoprene jacketed, not less than **2/64 inch (0.8 mm)** thick, over shield with filled interstices. Shield No. 34 AWG, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.
 - c. Plenum Cable: Listed and labeled for plenum installation.

S. Raceways

- 1. Conduit and Boxes: Comply with Division 26 Section "Raceway And Boxes For Electrical Systems". Flexible metal conduit shall not be used, unless directed otherwise.
 - a. Outlet boxes shall be not less than **2 inches (50 mm)** wide, **3 inches (75 mm)** high, and **2-1/2 inches (64 mm)** deep.

1.3 EXECUTION

A. Wiring Methods

- 1. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used, **as directed**. Conceal raceway and cables except in unfinished spaces.
 - a. Install plenum cable in environmental air spaces, including plenum ceilings.
 - b. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
- 2. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- 3. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

- B. Installation Of Raceways
 - 1. Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems" for installation of conduits and wireways.
 - 2. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- C. Installation Of Cables
 - 1. Comply with NECA 1.
 - 2. General Cable Installation Requirements:
 - a. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
 - b. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
 - c. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - d. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
 - e. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - f. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.
 - 3. Open-Cable Installation:
 - a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 - b. Suspend speaker cable not in a wireway or pathway a minimum of **8 inches (200 mm)** above ceiling by cable supports not more than **60 inches (1524 mm)** apart.
 - c. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.
 - 4. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least **12 inches (300 mm)** apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.
- D. Installation
 - 1. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
 - 2. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
 - 3. Equipment Cabinets and Racks:
 - a. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
 - b. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
 - c. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.
 - 4. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.
 - 5. Wall-Mounted Outlets: Flush mounted.
 - 6. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.

7. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.
8. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
9. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.
10. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

E. Grounding

1. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
2. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.
3. Install grounding electrodes as specified in Division 26 Section "Grounding And Bonding For Electrical Systems".

F. 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. Schedule tests with at least seven days' advance notice of test performance.
 - b. After installing public address and mass notification systems and after electrical circuitry has been energized, test for compliance with requirements.
 - c. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
 - d. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
 - 1) Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
 - 2) Repeat test for each separately controlled zone of loudspeakers.
 - 3) Minimum acceptance ratio is 50 dB.
 - e. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
 - f. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
 - g. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
 - h. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. Comply with testing requirements specified in Division 26 Section "Grounding And Bonding For Electrical Systems".

3. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.
4. Public address and mass notification systems will be considered defective if they do not pass tests and inspections.
5. Prepare test and inspection reports.
 - a. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

END OF SECTION 26 33 43 00b

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SECTION 26 51 33 00 - 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 26 51 33 00

Task	Specification	Specification Description
27 05 26 00	26 05 53 00a	Intercommunications and Program Systems

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SECTION 27 11 16 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. Sheet piling, 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 27 11 16 00

Task	Specification	Specification Description
27 11 16 00	26 05 53 00a	Intercommunications and Program Systems

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SECTION 27 11 19 00 - LOOSE-TUBE GEL-FILLED FIBER OPTIC CABLES

GENERAL

Description Of Work

1. This specification covers the furnishing and installation of loose-tube gel-filled fiber optic cables. 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.

Shop Drawings And Samples

2. The following shall be submitted:
 - a. Complete bill of materials.
 - b. Drawings indicating the locations of all pull boxes with station numbers.
 - c. Catalog data on all testing devices proposed for use plus certifications of accuracy, calibration, and traceability to standards of the National Institute for Standards and Testing.
 - d. Cable pulling calculations for all conduit runs. Indicate on the submittal any additional pull boxes that are required, including station number and a written description, of the location.
 - e. A cable pulling and splicing work plan shall be submitted a minimum of 45 days prior to the planned initiation of cable pulling. The pulling plan and pull tension calculations may be prepared by using a software program such as Pull-Planner 2000 by American Polywater Corporation. The cable pulling and splicing work plan must be approved a minimum of 15 days prior to pulling cable. Work plan shall include the following:
 - 1) Pull tension calculations
 - 2) Calculated amount of lubrication required
 - 3) Detailed description of pull operation methods for all conduit runs

Quality Assurance

3. All work described in this section shall meet or exceed the applicable provisions of the following documents:
 - a. ANSI C8.471983, American National Standard for Polyolefin Insulated Thermoplastic Jacketed Communication Cables.
 - b. EIA-455 (addendum 1 through 5) Standard Test Procedures for Fiber Optics, Cables, Transducers, Connecting and Terminating Devices.
 - c. EIA-455-27A, Method of Measuring (Uncoated) Diameter of Optical Waveguide Fibers.
 - d. EIA-455-28A, Method For Measuring Tensile Failure Point of Optical Waveguide Fibers.
 - e. EIA-455-34, Interconnection Device Insertion Loss Test.
 - f. EIA-455-89, Fiber Optic Cable Jacket Elongation and Tensile Strength.

Warranty

4. The Contractor shall provide an unconditional warranty on all installed cable for a minimum period of two (2) years.

PRODUCTS

Materials

5. Fiber Optic Cable - 24 strand
 - a. Cable type: Outdoor Plant Stranded Loose-Tube, Gel-Filled Fiber Optic Cable, Corning Altos 024RW4-14101A20 or Lucent Lightpack 7D1X-024-BXD.
 - b. Number of fibers: 24 fibers.
 - c. Buffer Tubes: All optical fibers shall be placed inside a loose buffer tube. The optical cable shall contain three buffer tubes, numbered 1, 2, and 3. The tubes shall be color coded according to the table below:

Buffer Tube Number	Buffer Tube Color
1	Blue
2	Orange
3	Green

- d. Each buffer tube shall contain 8 singlemode fibers. Each fiber shall be numbered and distinguishable by means of the color coding established in the main body of the specification.
 - e. The colors of the individual fibers shall be stable across the specified storage and operating temperature range and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.
 - f. The fibers shall not adhere to the inside walls of the loose buffer tube. Buffer tubes shall be kink resistant within the specified minimum bend radius.
 - g. Filler may be included in the cable core composition to lend symmetry to the cable cross-section where needed.
 - h. A central anti-buckling member shall be included into the cable to prevent buckling of the cable. The anti-buckling member shall be composed of a glass reinforced plastic rod.
 - i. Each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional nontoxic solvents.
 - j. Buffer tubes shall be stranded around a central member using the reverse oscillation, or "S-Z", stranding process.
 - k. The cable core shall contain a water-blocking material. The water blocking material shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt and foreign matter and shall be readily removable with conventional nontoxic solvents.
 - l. Binders shall be applied with sufficient tension to secure the buffer tubes to the member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking and dialectic with low shrinkage.
 - m. Tensile strength shall be provided by a combination of high tensile strength dielectric yarns. The high tensile strength dielectric yarns shall be helically stranded evenly around the cable core.
 - n. The all-dielectric cable shall be sheathed with medium density polyethylene (MDPE). The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and water blocking material. The jacket or sheath shall be free of holes, splits, and blisters. The cable jacket shall contain no metallic elements and shall be of a consistent thickness.
 - o. The cable shall contain at least one ripcord under the sheath for easy sheath removal.
6. Fiber Optic Cable - 36 Strand
- a. Cable type: Outdoor Plant Stranded Loose-Tube, Gel-Filled Fiber Optic Cable, Corning Altos 036RW4-14101A20 or Lucent Lightpack 7D1X-036-BXD.
 - b. Number of fibers: 36 fibers.
 - c. Buffer Tubes: All optical fibers shall be placed inside a loose buffer tube. The optical cable shall contain three buffer tubes, numbered 1, 2, and 3. The tubes shall be color coded according to the table below:

Buffer Tube Number	Buffer Tube Color
1	Blue
2	Orange
3	Green

- d. Each buffer tube shall contain 12 single mode fibers. Each fiber shall be numbered and distinguishable by means of the color coding established in the main body of the specification.

- e. The colors of the individual fibers shall be stable across the specified storage and operating temperature range and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.
- f. The fibers shall not adhere to the inside walls of the loose buffer tube. Buffer tubes shall be kink resistant within the specified minimum bend radius.
- g. Filler may be included in the cable core composition to lend symmetry to the cable cross-section where needed.
- h. A central anti-buckling member shall be included into the cable to prevent buckling of the cable. The anti-buckling member shall be composed of a glass reinforced plastic rod.
- i. Each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional nontoxic solvents.
- j. Buffer tubes shall be stranded around a central member using the reverse oscillation, or "S-Z", stranding process.
- k. The cable core shall contain a water-blocking material. The water blocking material shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt and foreign matter and shall be readily removable with conventional nontoxic solvents.
- l. Binders shall be applied with sufficient tension to secure the buffer tubes to the member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking and dielectric with low shrinkage.
- m. Tensile strength shall be provided by a combination of high tensile strength dielectric yarns. The high tensile strength dielectric yarns shall be helically stranded evenly around the cable core.
- n. The all-dielectric cable shall be sheathed with medium density polyethylene (MDPE). The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and water blocking material. The jacket or sheath shall be free of holes, splits, and blisters. The cable jacket shall contain no metallic elements and shall be of a consistent thickness.
- o. The cable shall contain at least one ripcord under the sheath for easy sheath removal.
- 7. Fan-Out Termination for Loose Tube Cables
 - a. Individual fibers within the loose tube cable require handling protection inside the termination cabinets. Fan-out kits shall be installed in the patch panel enclosures to transition the loose tube fibers to ruggedized tight-buffered fiber pigtail cables. Fan-out tubes or furcation kits shall not be used. Optical fusion splices shall connect the loose tube fibers to the tight-buffered pigtail cables. The optical splice loss shall comply with the specifications for optical splices. Splice protection sleeves shall be employed on all splices to protect the splices. A wall-mountable splice center shall house the splices and serve to fully protect excess lengths of loose tube fibers from exposure.
 - b. The tight-buffered pigtails shall be terminated with ST connectors as specified.
- 8. Fan-out Pigtail Cable Specifications
 - a. Singlemode fiber (Corning SMF-28) shall be used in the pigtails. Optical characteristics shall comply with the optical fiber performance specifications.

Buffer material	Thermoplastic
Buffer O.D.	900 um
Strength Member	Kevlar
Jacket Material	PVC
Jacket O.D.	3.0 mm
Temperature Range	-20 to +70 C

- 9. Fiber Optic Termination Patch Panels:
 - a. Where shown on the plans or in the Appendix, the fiber optic cable shall terminate inside a communications cabinet on a termination patch panel. All fiber sub-cables within the cable shall be terminated with "STTM compatible" connectors. The patch panel shall have a 24-fiber capacity, and shall facilitate fiber-optic cable cross-connection between outside plant

- cables and opto-electronic interface equipment cabling. The patch panel shall contain "ST™" type bayonet couplings. All unused couplings shall have protective dust covers. Factory-terminated, tight-buffered, aramid-reinforced fiber optic jumper assemblies or interconnect cables, standard 3.0-mm O.D., shall connect the optical cable terminations to the patch panel couplings.
- b. The termination panel shall be equipped with a suitable means for routing and securing of cables and shall provide a suitable means of protection for the mounted fiber connectors, to prevent damage to fibers and connectors during all regular operation and maintenance functions. Bend diameters on cable fibers and jumpers must be greater than four (4) inches at all times to ensure optical and mechanical integrity of the optical fibers.
10. Optical Connectors
- a. All connectors shall be field-installable and perfectly matched to the cable used. The connectors shall provide tight fitting termination, to the cladding and buffer coating. Epoxy-based or "hot melt" adhesives shall be used to bond the fiber and buffer to the connector ferrule and body prior to polishing the end face. No dry-termination or "quick crimp" connectors are allowed.
 - b. After termination with connectors, the fiber ends must be visually inspected at a magnification of not less than 100 power to check for cracks or pits in the end face of the fiber. If any irregularities found cannot be removed by further polishing, the entire process must be redone by cutting off and disposing the connector body.
 - c. Connectors shall have a maximum allowable connection loss of 0.3 dB per mated pair, as measured per EIA-455-34. No index-matching gel is to be used, dry interfaces only. Singlemode connectors shall be capable of field installation on 9/125 micron fibers with 900 micron buffers (OD).
 - d. Each connector shall be of the industry standard ST type compatible, designed for singlemode tolerances, and shall meet or exceed the applicable provisions of EIA-455-5, 455-2A, and 455-34, and shall be capable of 100 repeated matings with a maximum loss increase of 0.1 dB. Connectors shall incorporate a key-way design and shall have a zirconia ceramic ferrule. Connector bodies and couplings shall be made of corrosion-resistant and oxidation-resistant materials, such as nickel plated zinc, designed to operate in humid environments without degradation of surface finishes.
11. Splice Closures:
- a. Splice closures shall be of the re-enterable type, with an external moisture-proof shell, inner closure and encapsulant.
 - b. Closure shall have removable interior splice trays.
 - c. Closures shall be Corning Cable Systems (Siecor) type SCN or equal.

EXECUTION

Fiber Optic Cable Installation

12. General:
- a. The Contractor shall determine a suitable cable installation method to ensure that all cable installation requirements shall be met in all conduit sections. All work shall be carried out in accordance and consistent with the highest standards of quality and craftsmanship in the communication industry with regard to the electrical and mechanical integrity of the connections; the finished appearance of the installation; as well as the accuracy and completeness of the documentation.
 - b. The Contractor shall make a physical survey of the project site for the purpose of establishing the exact cable routing and cutting lengths prior to the commencement of any work or committing any materials.
 - c. The cable shall be carefully inspected for jacket defects as it is removed from the reel. If defects are noticed, the pulling operation shall be terminated immediately and the the Owner notified.

- d. Precautions shall be taken during installation to prevent the cable from being kinked or crushed. Crushed or kinked cable shall be replaced with new cable. As the cable is pulled into the conduit system, it shall be sufficiently lubricated with a lubricant that shall be the water-based type and approved by the cable manufacturer. Lubricant shall be applied at a rate to provide a continuous 10-mil coating, as recommended by the manufacturer. Lubricant shall be Polywater F® manufactured by American Polywater, or approved equivalent.
 - e. The mechanical stress placed upon the cable during installation shall not be such that the cable is twisted and stretched or exceeds manufacturer's specifications.
 - f. The pulling of the cable shall be hand assisted at each handhole or pullbox. When pulling through intermediate pullboxes, the cable shall be placed on the ground near the pullbox and care taken to prevent damage by vehicles or other objects. The cable shall not be crushed, kinked or forced around a sharp corner. A minimum of 3 foot slack shall be left in each pullbox and enough left at each end of the cable to allow proper cable termination.
13. Fiber optic cables shall be installed in continuous lengths without intermediate splices throughout the project. Cable installation personnel shall be familiar with the manufacturer's recommended procedures including, but not limited to the following:
- a. Proper attachment to the cable strength elements for pulling during installation. Depending on cable design, this will involve direct attachment to internal strength members or attaching an external "Kellums" or split mesh grip using a 600 lb breakaway swivel.
 - b. Cable tensile limitations and tension monitoring procedures.
 - c. Cable bending radius limitations.
 - d. Cable twisting limitations.
14. The Contractor shall comply with the cable manufacturer's recommended installation procedures at all times. Cable installation procedures shall conform to Belcore guidelines.
15. To accommodate long continuous installation lengths, bi-directional "center pull" techniques for pulling of the fiber optic cable is acceptable and shall be implemented as follows:
- a. From the midpoint, pull the fiber optic cable into the conduit from the shipping reel in accordance with the manufacturer's specifications.
 - b. When this portion of the pull is complete, the remainder of the cable must be removed from the reel to make the inside end available for pulling in the opposite direction.
 - c. This is accomplished by hand pulling the cable from the reel and laying into large "figure eight" loops on the ground.
 - d. The purpose of the figure eight pattern is to avoid cable tangling and kinking.
 - e. The loops shall be laid carefully one upon the other (to prevent subsequent tangling) and shall be in a protected area.
 - f. The inside reel end of the cable is then available for installation.
 - g. In some cases, it may be necessary to set up a winch at an intermediate cable vault.
 - h. The required length of cable shall be pulled to that point, and brought out of the cable vault and coiled into a figure eight.
 - i. The figure eight is then turned over to gain access to the free cable end. This can then be reinserted into the duct system for installation into the next section.
16. At pullboxes, the Contractor shall provide 30 feet of cable slack. The fiber optic cable shall be coiled and secured with cable ties in the pullbox. The Contractor shall ensure that the minimum bending radius of the fiber optic cable is not compromised when preparing this stored cable slack.
17. The pulling eye/sheath termination hardware on the fiber optic cables shall not be pulled over any sheave blocks.
18. When power equipment is used to install fiber optic cabling, the pulling speed shall not exceed 30 meters per minute. The pulling tension, bending radius and twist limitation for fiber optic cable shall not be exceeded under any circumstances.
19. Large diameter wheels, pulling sheaves, and cable guides shall be used to maintain the appropriate bending radius. Tension monitoring shall be accomplished using commercial dynamometers or loadcell instruments.
- a. All pulls shall be documented by a graph which is annotated with the following information:
 - 1) Reel number
 - 2) Station from and station to

- 3) Date and tune
- 4) Explanations of abnormalities in readings or interruptions
- 5) Sign-off by Contractor and the Owner
- b. Under no conditions shall the FOC be left exposed or unattended.
20. Repairs: Repair of cable jacket will not be permitted. Jacket damage will require removal and re-installation of a new cable run at the Contractor's expense.
21. Splicing:
 - a. Splicing of fiber optic cable shall not be permitted except in emergency conditions or as specified on the plans or in the special conditions for a specified project. Fiber optic cable runs and required looping of the cable shall be provided in one continuous length. When splicing is authorized by the the Owner, splicing shall be by trained, authorized persons only. Any allowed splicing of fiber optic cable shall be by fusion splice only, no mechanical splices are permitted.
 - b. All fusion splicing equipment shall be in good working order, properly calibrated, and meeting all industry standards and safety regulations. Cable preparation, closure installation and splicing shall be accomplished in accordance with accepted and approved industry standards.
 - c. Splices shall be made in pullboxes and shall use re-enterable splice closures.
 - d. The average splice loss shall be 0.1 dB or less per splice. The average splice loss is defined as the summation of the loss as measured in both directions using an optical time domain reflectometer (OTDR) through the fusion splice, divided by two. No individual splice loss measured in a single direction shall exceed 0.15 dB.
 - e. Upon completion of the splicing operation, all waste material shall be deposited in suitable containers, removed from the job site, and disposed of in an environmentally acceptable manner.
22. After the cables are installed and spliced, they shall be racked and all conduits sealed. A minimum of 30 feet of FOC shall be stored at each end of one splice. Racking shall conform to the following:
 - a. Cables shall be loosely secured in racked position with Ty-Raps or equal.
 - b. Imprinted plastic coated cloth identification/warning tags shall be securely attached to the cables in at least two locations in each handhole. Tags shall be by Brady or Thomas & Betts.
 - c. All coiled cable shall be suitably protected to prevent damage to the cable and fibers. Racking shall include securing cables to brackets and racking hardware that extend from the sidewalls of the handhole.
 - d. When all cables at each handhole are securely racked, unused conduits and void areas around conduit containing cables shall be sealed.

Cable Protection During Installation

23. All fiber optic cable shall be pulled in conduit except as specified on the plans. Care shall be exercised during cable pulls through conduit bends and looping in pull boxes.
24. To reduce the possibility of damage to the outer jacket of the fiber optic cable, protective measures shall be used when the cable is installed. The requirements herein shall be followed, but does not limit the installation to only those identified. The purpose of the installation specifications is to ensure protection, of the fiber optic cable when it is installed. Other protective measures not specified herein may be taken during installation if it will ensure protection of the cable.
25. A cable feeder guide shall be used between the cable reel and the face of the duct and conduit to protect the cable and guide it off the reel and into the duct. The cable shall be carefully inspected for jacket defects as it is removed from the reel. If defects are noticed, the pulling operation shall be terminated immediately and the the Owner notified.
26. Precautions shall be taken during installation to prevent the cable from being kinked, crushed or twisted. A pulling eye shall be attached to the cable end and be used to pull the cable through the duct and conduit system. As the cable is pulled off the reel and into the cable feeder guide, it shall

- be sufficiently lubricated with a lubricant that shall be of the water based type and approved by the cable manufacturer.
27. Dynamometers or break away pulling swings shall be used to ensure the pulling line tension does not exceed the installation tension values specified by the cable manufacturer. The mechanical stress placed upon the cable during installation shall not be such that the cable is twisted and stretched. Maximum allowable cable strain during installation shall be less than 0.75%.
 28. The pulling of the cable shall be hand assisted at each handhole or pullbox. The cable shall not be crushed, kinked or forced around a sharp corner. Sufficient slack shall be left at each end of the cable to allow proper cable termination.
 29. The cable shall be looped in all pull boxes as noted on the plans to provide approximately thirty (30) feet of extra cable in the pull box. At termination points, such as at cabinets or computers, a thirty (30) foot loop shall also be provided wherever space permits.
 30. Cable Marking: At each pullbox and at each cabinet, the cable shall be visibly marked with yellow warning tape as follows:

"CAUTION - FIBER OPTIC CABLE"

Fiber Optic Cable Testing

31. General: The Contractor shall perform pre-installation and post-installation FOC tests. The the Owner shall be notified a minimum of 10 days in advance so that these tests are witnessed. All test equipment shall be traceable to NIST standards.
32. Test equipment: The Contractor, shall use the following to perform pre-installation and post-installation FOC tests:
 - a. Optical time domain reflectometer (OTDR). The OTDR shall be laser precision, ALT Inc. MODEL 5200 LRFL, or equal.
33. Pre-installation tests
 - a. The purpose of these tests is to perform acceptance tests on the cable prior to installation to verify that the cable conforms to the manufacturer's specifications, and is free of defects, breaks and damages by transportation and manufacturing processes.
 - b. Prior to removal of each cable from the delivery reel, all optical fibers within the cables shall be tested by the Contractor using an OTDR. The OTDR tests shall consist of end-to-end length and fiber attenuation (dB/km) measurements to ensure proper performance of the fiber optic cable. The tests shall be performed from both ends of each fiber to ensure complete fiber continuity within the cable structure.
 - c. Pre-installation, "on-reel" test results shall be compared with the manufacturer's test report delivered with the cable. Gross dissimilarities shall be noted and remedied between the Contractor and manufacturer. In all cases, all fibers must meet the optical attenuation specifications prior to cable installation.
 - d. The Contractor shall perform tests on all reels of cable. The the Owner shall be notified a minimum of 15 days prior to any test.
 - e. The Contractor shall document each test and submit the report to the the Owner for review. Documentation shall consist of both hard copy and 3-1/2 inch electronic disk complete with all application software.
 - f. Cable shall not be installed until the the Owner has reviewed the test report.
 - g. Maximum allowable attenuation is 0.5 dB/km at 1310 and 1550 nm.
34. Post-installation tests: After FOC has been installed the following tests shall be performed:
 - a. A recording OTDR shall be used to test for end-to-end continuity and attenuation of each optical fiber. The OTDR shall be equipped with a 1310 nm and 1550 nm light source for the single mode fiber (SMF). The OTDR shall have an X-Y plotter to provide a hard copy record of each trace of each fiber: The OTDR shall be equipped with sufficient internal masking to allow the entire cable section to be tested. This may be achieved by using an optical fiber pigtail of 30 feet or more to display the required cable section.
 - b. The OTDR shall be calibrated for the correct index of refraction to provide proper length measurement for the known length of reference fiber.

- c. A transmission test shall be performed with the use of a 1310 and 1550 nm stabilized light sources and 1310 nm/1550 nm power meters for SMF. This test shall be conducted in both directions on each fiber of each cable.
 - d. Hard and electronic copy of test documentation shall be submitted to the the Owner. The documentation shall include the trace plot, index, dB/km loss, cable length, date and time of test, wavelength, pulse width, the test site, cable ID, fiber number and type, and operator's initials. The Contractor shall compare the pre-installation test results to the post-installation results. If a deviation of greater than one dB occurs, the the Owner shall be notified in writing by the Contractor, and the cable shall be removed and replaced at no additional cost to the Owner.
 - e. Upon completion of the previous tests all FOC coils shall be secured with ends capped to prevent intrusion of dirt and water.
35. Required OTDR Trace Information:
- a. All traces shall display the entire length of cable under test, highlighting any localized loss discontinuities (installation-induced losses and/or connector losses). The trace shall display fiber length (in kilofeet), fiber loss (dB), and average fiber attenuation (in dB/km) as measured between two markers placed as near to the opposite ends of the fiber under test as is possible while still allowing an accurate reading. Care shall be taken to ensure that the markers are placed in the linear region of the trace: away from the front-end response and far-end Fresnel reflection spike. Time averaging shall be used to improve the display signal to noise ratio. The pulse width of the OTDR shall be set to a sufficient width to provide adequate injected power to measure the entire length the fiber under test.
 - b. If connectors exist in the cable under test, then two traces shall be recorded. One trace shall record the fiber loss (dB) and average attenuation (dB/km) of the entire cable segment under test, including connectors. The second trace shall display a magnified view of the connector regions, revealing the connector losses (dB). All connector losses shall be measured using the 5-point splice loss measurement technique.
 - c. The OTDR trace shall also include the following information:
 - 1) The date and time of the test
 - 2) The cable ID number
 - 3) The cable segment ID number
 - 4) The fiber color or sub-cable number
 - 5) Launch point connector number
 - 6) The optical wavelength used for the test
 - 7) The refractive index setting of the OTDR
 - 8) The pulse width setting of the OTDR
 - 9) The averaging interval of the test

END OF SECTION 27 11 19 00

Task	Specification	Specification Description
27 11 19 00	27 11 16 00	Underground Storage Tank Removal
27 11 19 00	26 05 53 00a	Intercommunications and Program Systems
27 11 23 00	26 05 53 00a	Intercommunications and Program Systems
27 13 13 13	26 05 19 16c	Conductors And Cables
27 13 13 13	26 05 19 16d	Undercarpet Cables
27 13 13 13	26 05 19 16e	Medium-Voltage Cables
27 13 13 13	26 05 53 00a	Intercommunications and Program Systems
27 13 23 13	27 11 19 00	Loose-Tube Gel-Filled Fiber Optic Cables
27 15 13 00	26 05 19 16c	Conductors And Cables
27 15 13 00	26 05 19 16d	Undercarpet Cables
27 15 13 00	26 05 23 00	Control-Voltage Electrical Power Cables
27 15 13 00	26 05 19 16e	Medium-Voltage Cables
27 15 33 00	26 05 19 16c	Conductors And Cables
27 15 33 00	26 05 19 16d	Undercarpet Cables
27 15 33 00	26 05 23 00	Control-Voltage Electrical Power Cables
27 15 33 00	26 05 19 16e	Medium-Voltage Cables
27 15 43 00	26 05 53 00a	Intercommunications and Program Systems
27 15 53 00	27 11 19 00	Loose-Tube Gel-Filled Fiber Optic Cables
27 16 16 00	27 11 19 00	Loose-Tube Gel-Filled Fiber Optic Cables
27 16 19 00	26 05 19 16c	Conductors And Cables
27 16 19 00	27 11 19 00	Loose-Tube Gel-Filled Fiber Optic Cables
27 21 16 00	27 11 19 00	Loose-Tube Gel-Filled Fiber Optic Cables
27 31 13 00	27 11 16 00	Underground Storage Tank Removal
27 31 13 00	26 05 53 00a	Intercommunications and Program Systems
27 32 13 00	27 11 16 00	Underground Storage Tank Removal
27 32 13 00	26 05 33 16a	Wiring Devices
27 32 13 00	26 05 53 00a	Intercommunications and Program Systems
27 32 26 00	27 11 16 00	Underground Storage Tank Removal
27 32 26 00	26 05 53 00a	Intercommunications and Program Systems

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SECTION 27 51 23 50 - EDUCATIONAL INTERCOMMUNICATIONS AND PROGRAM SYSTEMS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for educational intercommunications and program 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. Section Includes: Manually switched intercommunications, Microprocessor-switched intercommunications, Microprocessor-switched telephone/intercommunications and program systems with the following components:
 - a. Master stations.
 - b. Call control console.
 - c. Speaker-microphone stations.
 - d. Call-switch unit.
 - e. All-call amplifier.
 - f. Intercommunication amplifier.
 - g. Paging amplifier.
 - h. Loudspeakers/speaker microphones.
 - i. Conductors and cables.
 - j. Raceways.

C. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: For educational intercommunications and program systems. Include plans, elevations, sections, details, and attachments to other work.
 - a. Wiring Diagrams: For power, signal, and control wiring.
 - 1) Identify terminals to facilitate installation, operation, and maintenance.
 - 2) Single-line diagram showing interconnection of components.
 - 3) Cabling diagram showing cable routing.
3. Field quality-control reports.
4. Operation and maintenance data.

D. Quality Assurance

1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for location and application.
3. Comply with NFPA 70.

1.2 PRODUCTS

A. Functional Description Of Manually Switched Systems

1. Master Station:
 - a. Communicating selectively with other master and speaker-microphone stations by actuating selector switches.
 - b. Communicating simultaneously with all other stations by actuating a single all-call switch.
 - c. Communicating with individual stations in privacy.
 - d. Including other master-station connections in a multiple-station conference call.

- e. Accessing separate paging speakers or groups of paging speakers by actuating selector switches.
- f. Overriding any conversation by a designated master station.
- 2. Speaker-Microphone Station:
 - a. Having privacy from remote monitoring without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls.
 - b. Communicating hands free.
 - c. Calling master station by actuating call switch.
 - d. Returning a busy signal to indicate that station is already in use.
 - e. Being free of noise and distortion during operation and when in standby mode.
- 3. Speakers: Free of noise and distortion during operation and when in standby mode.

B. Functional Description Of Microprocessor-Switched Systems

- 1. Master Station:
 - a. Communicating selectively with other master and speaker-microphone stations by dialing station's number on a 12-digit keypad.
 - b. Communicating with individual stations in privacy.
 - c. Communicating on a minimum of three voice channels with up to two simultaneous conversations between master stations and one conversation between a master station and a speaker-microphone station.
 - d. Increasing the number of conversation channels by adding a module in central-control cabinet.
 - e. Including up to three other station connections in a conference call.
 - f. Accessing separate paging speakers or groups of paging speakers by dialing designated numbers on a 12-digit keypad.
 - g. Overriding any conversation by a designated master station.
 - h. Displaying selected station.
 - i. Communicating simultaneously with all other stations by dialing a designated number on a 12-digit keypad.
 - j. Automatically controlling gain to ensure constant intercom speech level.
 - k. Controlling the simultaneous distribution of program material to various combinations of speaker-microphone stations or groups over two program channels by using keypad to control sources and distribute programs.
 - l. Operating and correcting secondary clocks and controlling class-change signals to speakers and bells by using keypad.
 - m. User-programmable features include the following:
 - 1) Station calling by room number.
 - 2) Room station call-in priority levels.
 - 3) Clock signal schedule functions.
 - 4) Schedule characteristics of audible signals.
 - 5) Call-in tone characteristic.
 - 6) Precedence among master stations as destinations for incoming calls from room stations.
 - 7) Grouping of rooms and speakers into zones for paging and program distribution purposes.
- 2. Speaker-Microphone Station:
 - a. Having privacy from remote monitoring without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls.
 - b. Communicating hands free.
 - c. Calling master station by actuating call switch.
 - d. Returning a busy signal to indicate that station is already in use.
- 3. Speakers: Free of noise and distortion during operation and when in standby mode.

C. Functional Description Of Telephone/Intercommunication Systems

1. Integrated central system with the following:
 - a. Direct-dial, full duplex private telephone communications between all locations equipped with telephones. Call initiation among master stations and between master and remote stations by dialing station's number on a 12-digit keypad.
 - b. 16 channels for unrestricted simultaneous communications.
 - c. Initial system operation with **<Insert number>** master and remote stations, expandable to 360 stations.
 - d. Direct-dial, two-way amplified voice intercommunication between master telephones and remote stations without use of press-to-talk or talk-listen switches.
 - e. Automatic queuing for intercommunication channels, with automatic call waiting.
 - f. Call transfer among master stations.
 - g. Display of selected station and answering calling station by pressing a single "response button."
 - h. Simultaneous communication with other stations on system by dialing a designated number on a 12-digit keypad.
 - i. Automatic gain control to ensure constant intercom speech level.
 - j. Simultaneous distribution of emergency announcements to all locations equipped with speakers by dialing a predetermined code number.
 - k. User-selectable facility for providing selected telephones with dial tone.
 - l. User-selectable facility for permitting linkage of selected stations to media retrieval center and for permitting on- and off-premise computer linkage.
 - m. Assignment of speaker locations within any one or more of eight zones for zone paging or time signal reception.
 - n. Digital readout displays on which up to three incoming calls are displayed with additional calls stored for subsequent display.
 - o. Off-site diagnostics through a serial data port on central-control station.
 - p. Control of simultaneous distribution of program material to various combinations of remote stations or groups by using keypad to control sources and distribute programs.
 - q. Operation and correction of secondary clocks and control of class-change signals to speakers and bells by using keypad.
 - r. User-programmable features include the following:
 - 1) Station calling by room number.
 - 2) Room station call-in priority levels.
 - 3) Clock signal schedule functions.
 - 4) Schedule characteristics of audible signals.
 - 5) Call-in tone characteristic.
 - 6) Precedence among master stations as destinations for incoming calls from room stations.
 - 7) Grouping rooms and speakers into zones for paging and program distribution purposes.
 - s. Telephone interconnect features include the following:
 - 1) Direct connection to central office trunk lines with initial system wiring for **<Insert number>** trunk lines.
 - 2) Routing of outside trunk lines for "attendant answer incoming" and "direct inward line" functions.
 - 3) Station programming for access to outside trunk lines to be any of the following:
 - a) Totally unrestricted access.
 - b) Restricted access.
 - c) No access.
 - 4) System programming to allow or disallow local prefixes, and to authorize access for as many as three area codes.
 - 5) Discriminating ringing for identifying internal and outside calls.
 - 6) Circular hunting for outside trunks to prevent excess usage of any one trunk.
 - 7) Direct connection of a single trunk to designated telephone with transfer to attendant if unanswered.

- 8) Call parking allowing paged party to remotely pick up outside call from any master station.
- 9) Night-answer mode to allow one or all of the following:
 - a) Incoming call transferred to predetermined extension.
 - b) Tone transmitted to speakers to notify key personnel to answer telephone.
 - c) Dial tone to remote stations to allow answering call from all locations.
- 10) Call control console to do as follows:
 - a) Identify, answer, and route incoming outside calls, with reminder and recall features.
 - b) Directly access outside trunk lines.
 - c) Hold, park, and transfer calls.
 - d) Screen outside calls.
2. Remote Stations:
 - a. Speaker-Microphone Station:
 - 1) Having privacy from remote monitoring without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls.
 - 2) Communicating hands free.
 - 3) Calling master station by actuating call switch.
 - 4) Returning a busy signal to indicate that station is already in use.
3. Speakers: Free of noise and distortion during operation and when in standby mode.

D. General Requirements For Equipment And Materials

1. Coordinate features and select components to form an integrated system. Match components and interconnections for optimum performance of specified functions.
2. Expansion Capability: Increase number of stations in the future by 25 percent above those indicated without adding any internal or external components or main trunk cable conductors.
3. Equipment: Modular type using solid-state components, fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz. Comply with UL 813.
4. Weather-Resistant Equipment: Listed and labeled by an NRTL for duty outdoors or in damp locations.

E. Master Station For Manually Switched Systems

1. Station-Selector and Talk-Listen Switches: Heavy-duty type with gold-plated contacts rated for five million operations.
2. Volume Control: Regulates incoming-call volume.
3. LED Annunciation: Identifies calling stations and stations in use. LED remains on until call is answered.
4. Tone Annunciation: Momentary audible tone signal announces incoming calls.
5. Speaker Microphone: Transmits and receives calls.
 - a. Minimum Speaker Sensitivity: 91 dB at one meter, with 1-W input.
6. Handset with Hook Switch: Telephone type with 18-inch- (450-mm-) long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.
7. Central-Equipment Cabinet: Comply with TIA/EIA-310-D. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, and auxiliary equipment.

F. Master Station For Microprocessor-Switched Systems

1. 12-Digit Keypad Selector: Transmits calls to other stations and initiates commands for programming and operation.
2. Volume Control: Regulates incoming-call volume.
3. Tone Annunciation: Momentary audible tone signal announces incoming calls.
4. Lamp Annunciation: Identifies calling stations and stations in use. Lamp remains on until call is answered.

5. Speaker Microphone: Transmits intercom voice signals when used via a voice-operated switch.
 - a. Minimum Speaker Sensitivity: 91 dB at one meter, with 1-W input.
 6. Link Button: To transfer calls.
 7. Reset Control: Cancels call and resets system for next call.
 8. Digital Display: 16-digit alphanumeric LCD readout to register up to four three-digit station numbers.
 9. Central-Equipment Cabinet: Comply with TIA/EIA-310-D. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, and other switching and control devices required for conversation channels and control functions.
- G. Call Control Console
1. Microprocessor-based instrument to process outside and internal calls with a 12-digit keypad selector.
 2. 20-character alphanumeric display for the following:
 - a. Simultaneous display of up to three calling stations plus last station dialed.
 - b. Display of calls in order received with emergency calls taking precedence on the display.
 - c. Review of calls stored in groups of four.
 - d. Display of prompt messages to assist in system operation.
 3. Programmable Keys: Minimum of 20 with LED indicators for ringing/busy status; programmable for trunk and operator functions.
 4. Transfer Button: Calls to busy extensions and unanswered calls automatically returned to call control console.
 5. Hold Button: With reminder feature every 30 seconds for parked calls or calls placed on hold.
 6. Release Button: For use with parked calls or calls placed on hold.
 7. Page Button: For engaging system paging functions.
 8. Programmable for night answer, remote answer, and remote pickup features.
 9. Programmable for distribution of emergency announcements, all-page announcements, zone-page announcements, and emergency/evacuation alert.
 10. Central-Control Cabinet Equipment: Central switching equipment, central office adapter module, line link modules, power supplies, chassis adapters, and other switching and control devices required for trunk and internal conversation channels and control functions.
- H. Speaker-Microphone Stations
1. Mounting: Flush unless otherwise indicated, and suitable for mounting conditions indicated.
 2. Faceplate: Stainless steel or anodized aluminum with tamperproof mounting screws.
 3. Back Box: Two-gang galvanized steel with 2-1/2-inch (64-mm) minimum depth.
 4. Speaker: Minimum axial sensitivity shall be 91 dB at one meter, with 1-W input. Voice coil shall be not less than 3 inches (76 mm), 2.3 oz. (65 g) minimum; permanent magnet.
 5. Tone Annunciation: Recurring momentary tone indicates incoming calls.
 6. Call Switch: Mount on faceplate. Permits calls to master station.
 7. Privacy Switch: Mount on faceplate. When in on position, switch prevents transmission of sound from remote station to system; when in off position, without further switch manipulation, response can be made to incoming calls.
- I. Call-Switch Unit
1. Enclosure: Single-gang box with stainless-steel faceplate.
 2. Call Switch: Momentary contact signals system that a call has been placed.
 3. Privacy Switch: Prevents transmission of sound signals from station to system.
 4. Volume Control: Operated by screwdriver blade through a hole in faceplate to adjust output level of associated speaker.
- J. All-Call Amplifier
1. Output Power: 70-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus an allowance for future stations.

2. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to quantity of stations connected in all-call mode of operation.
 3. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.
 4. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.
 5. Output Regulation: Maintains output level within 2 dB from full to no load.
 6. Input Sensitivity: Compatible with master stations and central equipment so amplifier delivers full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on master stations, speaker microphones, or handset transmitters.
 7. Amplifier Protection: Prevents damage from shorted or open output.
- K. Intercommunication Amplifier
1. Minimum Output Power: 15 W; adequate for all functions.
 2. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to one station connected to output terminals.
 3. Minimum Signal-to-Noise Ratio: 50 dB, at rated output.
 4. Frequency Response: Within plus or minus 3 dB from 70 to 10,000 Hz.
 5. Output Regulation: Maintains output level within 2 dB from full to no load.
 6. Input Sensitivity: Matched to input circuit and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on microphones in master stations, speaker microphones, or handset transmitters.
 7. Amplifier Protection: Prevents damage from shorted or open output.
- L. Paging Amplifier
1. Input Voltage: 120-V ac, 60 Hz.
 2. Frequency Response: Within plus or minus 3 dB from 60 to 10,000 Hz.
 3. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.
 4. Total Harmonic Distortion: Less than 3 percent at rated output power from 70 to 12,000 Hz.
 5. Output Regulation: Less than 2 dB from full to no load.
 6. Controls: On-off, input levels, and low-cut filter.
 7. Input Sensitivity: Matched to input circuit and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphones or handset transmitters.
 8. Amplifier Protection: Prevents damage from shorted or open output.
- M. Cone-Type Loudspeakers/Speaker Microphones
1. Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.
 2. Frequency Response: Within plus or minus 3 dB from 70 to 15,000 Hz.
 3. Minimum Dispersion Angle: 100 degrees.
 4. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.
 5. Enclosures: Steel housings or back boxes, acoustically dampened, with front face of at least **0.0478-inch (1.2-mm)** steel and whole assembly rust proofed and factory primed; complete with mounting assembly and suitable for surface ceiling, flush ceiling, pendant or wall mounting; with relief of back pressure.
 6. Baffle: For flush speakers, minimum thickness of **0.032-inch (0.8-mm)** aluminum brushed to a satin sheen and lacquered **OR** with textured white finish, **as directed**.
 7. Vandal-Proof, High-Strength Baffle: For flush **OR** surface, **as directed**, -mounted speakers, self-aging cast aluminum with tensile strength of **44,000 psi (303 MN/sq. m)**, **0.025-inch (0.65-mm)** minimum thickness; countersunk heat-treated alloy mounting screws; and textured white epoxy finish.
 8. Size: **8 inches (200 mm)** with **1-inch (25-mm)** voice coil and minimum **5-oz. (140-g)** ceramic magnet.
- N. Horn-Type Loudspeakers/Speaker Microphones
1. Speakers shall be all-metal, weatherproof construction; complete with universal mounting brackets.

2. Frequency Response: Within plus or minus 3 dB from 275 to 14,000 Hz.
3. Minimum Power Rating of Driver: 15 W, continuous.
4. Minimum Dispersion Angle: 110 degrees.
5. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.

O. Conductors And Cables

1. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.
2. Insulation: Thermoplastic, not less than **1/32 inch (0.8 mm)** thick.
3. Shielding: For speaker-microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil.
 - a. Minimum Shielding Coverage on Conductors: 60 percent.
4. Plenum Cable: Listed and labeled for plenum installation.

P. Raceways

1. Educational Intercommunication and Program System Raceways and Boxes: Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems".
2. Educational Intercommunication and Program System Raceways and Boxes: Same as required for electrical branch circuits specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
3. Educational Intercommunication and Program System Raceways and Boxes: EMT **OR** ENT **OR** RNC **OR** Optical-fiber/communication raceways and fittings **OR** Metal wireways **OR** Nonmetal wireways **OR** Surface metal raceways **OR** Surface nonmetal raceways, **as directed**.
4. Outlet boxes shall be not less than **2 inches (50 mm)** wide, **3 inches (75 mm)** high, and **2-1/2 inches (64 mm)** deep.
5. Flexible metal conduit is prohibited.

1.3 EXECUTION

A. Wiring Methods

1. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used, **as directed**. Conceal raceway and cables except in unfinished spaces.
 - a. Install plenum cable in environmental air spaces, including plenum ceilings.
 - b. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
2. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
3. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

B. Installation Of Raceways

1. Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems" for installation of conduits and wireways.
2. Install manufactured conduit sweeps and long-radius elbows whenever possible.

C. Installation Of Cables

1. Comply with NECA 1.
2. General Requirements:
 - a. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.

- b. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
 - c. Secure and support cables at intervals not exceeding **30 inches (760 mm)** and not more than **6 inches (150 mm)** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - d. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
 - e. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - f. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.
3. Open-Cable Installation:
- a. Install cabling with horizontal and vertical cable guides in telecommunication spaces with terminating hardware and interconnection equipment.
 - b. Suspend speaker cable not in a wireway or pathway a minimum of **8 inches (200 mm)** above ceiling by cable supports not more than **60 inches (1524 mm)** apart.
 - c. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.
4. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least **12 inches (300 mm)** apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

D. Installation

- 1. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
- 2. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
- 3. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
- 4. Connect wiring according to Division 26 Section "Grounding And Bonding For Electrical Systems".

E. Grounding

- 1. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- 2. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.
- 3. Install grounding electrodes as specified in Division 26 Section "Grounding And Bonding For Electrical Systems".

F. System Programming

- 1. Programming: Fully brief the Owner on available programming options. Record the Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

G. 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. Schedule tests with at least seven days' advance notice of test performance.
 - b. After installing educational intercommunications and program systems and after electrical circuitry has been energized, test for compliance with requirements.
 - c. Operational Test: Test originating station-to-station **OR** originating station-to-station, all-call, and page, **as directed**, messages at each intercommunication station. Verify proper routing and volume levels and that system is free of noise and distortion. Test each available message path from each station on system.
 - d. Frequency Response Test: Determine frequency response of two transmission paths, including all-call and paging, **as directed**, by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 150 to 2500 Hz.
 - e. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
 - 1) Disconnect speaker microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure signal-to-noise ratio at paging, **as directed**, speakers.
 - 2) Repeat test for three speaker microphones, one master station microphone, and for each separately controlled zone of paging loudspeakers.
 - 3) Minimum acceptable ratio is 45 dB.
 - f. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into each intercom **OR** intercom, paging, and all-call amplifier, **as directed**. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics.
 - g. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each paging zone. Maximum permissible variation in level is plus or minus 3 dB; in levels between adjacent zones, plus or minus 5 dB.
 - h. Power Output Test: Measure electrical power output of each paging amplifier at normal gain settings of 150, 1000, and 2500 Hz. Maximum variation in power output at these frequencies is plus or minus 3 dB.
 - i. Signal Ground Test: Measure and report ground resistance at system signal ground. Comply with testing requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".
3. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging and independent room speaker-line matching transformers.
4. Educational intercommunications and program systems will be considered defective if they do not pass tests and inspections.
5. Prepare test and inspection reports.

END OF SECTION 27 51 23 50

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Task	Specification	Specification Description
27 51 23 50	26 05 53 00a	Intercommunications and Program Systems
27 51 33 00	27 51 23 50	Educational Intercommunications and Program Systems
27 51 33 00	26 33 43 00b	Public Address and Mass Notification Systems

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SECTION 27 53 13 13 - CLOCK AND PROGRAM CONTROL

1.1 GENERAL

A. Description Of Work

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

B. Summary

1. Section Includes:
2. Master clock and program control unit.
3. Secondary indicating clocks.
4. Program signal devices.
5. Clock circuit power boosters.
6. Interface with intercom and public-address system.
7. System wire and cable.

C. Definitions

1. NIST: The National Institute of Science and Technology.
2. PC: Personal computer.
3. UTC: Universal time coordinated. The precisely measured time at zero degrees longitude; a worldwide standard for time synchronization.

D. Performance Requirements

1. Seismic Performance: Master clock and housing shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
2. 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."

E. Submittals

1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes (including available colors) for each product indicated and describe features and operating sequences, both automatic and manual.
2. Shop Drawings: For clock systems. Include plans, elevations, sections, details, and attachments to other work.
 - a. Wiring Diagrams: For power, signal, and control wiring and correction circuits.
 - 1) Identify terminals and wiring color codes to facilitate installation, operation, and maintenance.
 - 2) Indicate recommended wire types and sizes, and circuiting arrangements for field-installed system wiring. Show protection from overcurrent, static discharge, and voltage surge.
 - b. Details of seismic restraints including mounting, anchoring, and fastening devices for the following system components:
 - 1) Surface-mounted and semirecessed secondary indicating clocks.
 - 2) Master clock enclosures **OR** mounting racks, **as directed**.
 - 3) Clock circuit power boosters.
 - c. Details of seismic strengthening of master clock enclosures **OR** mounting racks, **as directed**.

- d. Dimensioned Outline Drawings of the Mounting Rack for the Master Clock: Show internal seismic bracing, and locate center of gravity of fully equipped and assembled unit. Locate and describe mounting and anchorage provisions.
- 3. Delegated-Design Submittal: For the master clock and housing 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 the master clock and housing.
 - b. Design Calculations: Calculate requirements for selecting seismic restraints.
- 4. Seismic Qualification Certificates: For the master clock, accessories, and components, from manufacturer.
- 5. Field quality-control reports.
- 6. Operation and maintenance data.

F. 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. Master And Secondary Clock System

- 1. System Functions and Features:
 - a. Supply power to remote indicating clocks except those indicated to have correction signals applied through a data circuit.
 - b. Maintain correct synchronized time and transmit time-correction signals over dedicated system wiring from a master clock to any one **OR** two, **as directed**, type(s) of secondary indicating clocks, including the following:
 - 1) Analog Synchronous Clocks: Correct for minute- and second-hand synchronization at least once each hour and for hour-hand synchronization at least once each day.
 - 2) Digital Clocks: Test clocks automatically for synchronization with master time control at least once every hour and automatically correct those not synchronized with the time reference unit. Automatically correct clocks immediately when power is restored after an outage of power to the master clock.
 - c. Initiate and execute programs for scheduled automatic operation of remote devices. Include audible signal devices and visual signal devices, **as directed**, and on and off switching of equipment and circuits, **as directed**.
 - d. Provide for manual control of programmed signal and equipment-switching circuits.
 - e. Communicate with remote PC for access to UTC time base and to permit programming from remote location, **as directed**.
 - f. Maintain system access security with a minimum of one level **OR** two levels **OR** three levels, **as directed**, of user-access control to restrict use of system controls to authorized personnel. Levels of access apply to both local access and access from a remote computer, **as directed**. Access to user programming and control functions is accomplished by entering a minimum three-digit code. Access levels include the following:
 - 1) Access to review existing programs only.
 - 2) Access to normal system operating controls.
 - 3) Access to all user-programming and control functions.
 - g. Regulate system timing functions using power-line frequency, backed up for power outages by an internal battery-powered, crystal-controlled oscillator.
OR
 Regulate system timing functions using power-line frequency, backed up for power outages by an internal battery-powered, crystal-controlled oscillator, and automated periodic reference to NIST or UTC time signals via internal telephone modem and automatic dialup connection **OR** internal modem and network or microcomputer Internet

access **OR** dedicated internal radio receiver tuned to NIST time signal broadcasts, **as directed**. Reference time signals shall be automatically accessed at programmable intervals.

- h. Provide for programming multiple independent event schedules into memory and running them simultaneously for different output circuits.
 - 1) Quantity of Programmable Schedules: Three **OR** Four **OR** Eight **OR** 18 **OR** 250, **as directed**, minimum.
 - 2) Number of Weekly Events That Can Be Programmed for Each Schedule: 64 **OR** 128 **OR** 300 **OR** 600 **OR** 2500, **as directed**, minimum.
 - 3) Simultaneous operation of independent schedules shall be limited only by the number of signal-device and equipment-switching output circuits.
 - 4) Advance Programming for Automatic Holiday Schedule Changes: Number of schedule changes that can be programmed to suit holidays and vacations shall be 10 **OR** 16 **OR** 50 **OR** 100, **as directed**, and each change may be programmed up to a year in advance to occur on any day of the calendar year.
- i. Automatically check functioning of LEDs, switches, input keys, central processor, read-only memory, random access memory, and output circuits. A display on the control panel or a remote computer with the proper access code, **as directed**, shall indicate failure by identifying faulty component or circuit and shall recommend corrective action.
- j. Provide manually initiated **OR** programming for automatic, **as directed**, daylight savings time correction.
- k. Provide for adjustments to master clock output signals. Duration of momentary signal shall be individually programmable for each signal and equipment-control output circuit from 1 to 99 seconds. Signals shall be programmable for either on or off switching to suit equipment-operation scheduling.

B. Master Clock

- 1. Description: Microprocessor-based, software-controlled unit complying with Class A device requirements in 47 CFR 15.
 - a. Programming and control switches.
 - b. Informational Display: LED or backlit LCD type.
 - 1) Normally shows current time, date, and day of week, **as directed**, display.
 - 2) Provides programming cues when system is being programmed.
 - c. Output Circuits for Power and Correction of Secondary Indicating Clocks:
 - 1) Wired Synchronous Clock Power-and-Correction Circuits: For analog and digital, **as directed**, clocks; a minimum of one **OR** two, **as directed**, required. Relay controlled.
OR
Wired Synchronous Digital Clock Power-and-Correction Circuits: One, **as directed**, required.
 - 2) Existing Clock Power-and-Correction Circuit: An output circuit suitable for the of existing power-and-correction circuit and number of clocks to be connected.
 - d. Data Output Port for Digital, **as directed**, Secondary Clock Correction Circuit: RS485 or similar circuit for scheduled periodic correction signals.
 - e. Modem and PC interface software suitable for remote programming and automatic NIST or UTC synchronization, **as directed**.
 - f. Circuits for Audible and Visual, **as directed**, Signal Devices: Relay controlled, manually switchable, using controls on the master clock. Rated 120-V ac, five **OR** 10, **as directed**, A minimum. A minimum of two **OR** four **OR** six **OR** eight, **as directed**, circuits.
 - g. Circuits for Programmable Switching of Remote Equipment and Circuits: Relay controlled, manually switchable, using controls on the master clock. Rated 120-V ac, 5 **OR** 10, **as directed**, A minimum. A minimum of two **OR** four **OR** six **OR** eight, **as directed**, circuits.
 - h. Power Supplies: Capacity for internal loads and power-and correction circuits of connected clocks.

- i. Enclosure: Metal cabinet with locking front panel. When cabinet is locked, display indication shall be visible on or through front panel face. Arrange cabinet for surface, semirecessed, or flush mounting as indicated.
OR
 Housing: Rack-mounting metal enclosure with display indication visible on front panel face.
 - 1) Reinforce mounting and attachment capable of resisting seismic forces described in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
- j. Battery Backup for Time Base: Lithium battery to maintain the timekeeping function and retain the programs in memory during outage of normal ac power supply for up to 10 years.
- k. Electrostatic Discharge Resistance: Master clock and secondary indicating clocks, **as directed**, shall be tested and certified according to IEC 61000-4-2 in both human-discharge and direct-injection modes.

C. Secondary Indicating Clocks

- 1. Analog Clock: Equipped with a sweep second hand. Movement shall be driven by self-starting, permanently lubricated, sealed synchronous motor equipped with a correcting solenoid actuator, or be a microprocessor-based, second impulse unit, compatible with the master clock.
- 2. Digital Clock: Microprocessor-controlled unit complying with Class A device requirements in 47 CFR 15, with red LED digital time display of hours and minutes **OR**, minutes, and seconds, **as directed**.
 - a. Display Height: 2-1/2-Inch (64-mm) Clock: Hour and minute numerals readable at 50 feet (15 m).
OR
 Display Height: 4-Inch (102-mm) Clock: Hour and minute numerals readable at 100 feet (30 m).
 - b. Display Format: Selectable between 12-hour with "PM" LED display and 24-hour formats.
 - c. Connections for Power and Correction:
 - 1) Wired synchronous connection to the master clock for both operating power and correction.
 - a) Time-Base Backup: Internal alkaline battery shall back up internal time base to maintain timekeeping during power outages of up to six days' duration.
OR
 Time-Base Backup: Internal capacitor shall back up internal time base to maintain timekeeping during power outages of up to 12 hours' duration.
 - b) Correction by RS485, Ethernet, or similar data line with operating power supplied over a separate connection.
 - c) Power Connection for Secondary Indicating Clocks: Plug connector **OR** Wire pigtail or compression splice, **as directed**.
- 3. Interval-Timer Clock: Digital microprocessor-controlled, 4-inch (102-mm) unit with 2-1/2-inch (64-mm), red LED digital display for hours and minutes and 1-5/16-inch (33-mm) display for seconds; a separately mounted, mode-control switch; and the following features:
 - a. Display Visibility: Hour and minute numerals readable at 30 feet (10 m) in normal ambient light.
 - b. Operating Modes:
 - 1) Normal: Clock operates as a regular secondary system clock, displaying corrected time in normal display configuration, selectable between 12- and 24-hour formats, with "PM" digital display for 12-hour format.
 - 2) Count-Down or Count-Up Timer: Selected by mode-control switch count-up and count-down positions, and capable of being preset at the mode-control station.
 - 3) Code Blue: Automatically selected by a signal through a wiring connection from the code-blue system. This signal captures control of the clock regardless of current mode or correction status and instantly initiates count-up operation, starting at time 00:00:00. While in this mode, other clock functions, including correction, shall run in

- the background. Clock shall revert to normal operating mode when the initiating-signal system is reset.
- c. Mode-Selector Switch: Push-button or rotary, multiposition type, flush mounted; with start, stop, and reset capability in both count-up and count-down modes.
 - d. Audible tone signal: Housed in clock or mode-selector-switch box. Sounds at end of preset up or down count.
4. Provision for Modular Panel Installation: Equip designated clock for panel mounting. Mount flush or semirecessed with arrangement and trim as indicated. Coordinate wiring with other modular panel components, including room lighting switches **OR** intercom devices **OR** convenience outlets **OR** data outlets **OR** speaker **OR** other similar devices, **as directed**.
 5. Provision for Time-Tone-Unit Installation: Equip indicated clocks for housing or mounting in an acoustically treated and baffled speaker compartment specified in Division 27 Section "Public Address And Mass Notification Systems".
- D. Secondary Indicating Clock Characteristics:
- a. Clock Type: Analog **OR** Digital, **as directed**.
 - b. Face Configuration: Single **OR** Double, **as directed**.
 - c. Mounting: Recessed **OR** Semirecessed **OR** Pendant **OR** Surface **OR** Suspended **OR** Within time-tone unit **OR** Within modular panel, **as directed**.
 - d. Nominal Dimensions: as directed by the Owner.
 - e. Casing Finish: Types and colors, as directed by the Owner.
 - f. Special Environmental Conditions: Describe conditions such as corrosive, damp, or wet locations, as directed by the Owner.
 - g. For analog clocks.
 - 1) Dial Face Color: as directed by the Owner.
 - 2) Analog Clock Crystal: Clear glass **OR** acrylic **OR** polycarbonate, **as directed**.
 - h. For digital clocks.
 - 1) Face Color: as directed by the Owner.
 - 2) Display Height: as directed by the Owner.
 - 3) Seconds Display: Yes **OR** No, **as directed**.
 - 4) Digital Clock Lens: Antiglare acrylic material.
 - 5) Battery Backup: Yes **OR** No, **as directed**.
 - 6) Interval-Timer Display: Yes **OR** No, **as directed**.
- E. Program Signal Devices
1. Bells: Heavy-duty, modular, vibrating type with the following sound-output ratings measured at 10 feet (3 m):
 - a. 4-Inch (100-mm) Bell: 90 dB.
 - b. 6-Inch (150-mm) Bell: 95 dB.
 - c. 10-Inch (250-mm) Bell: 104 dB.
 2. Chimes: Heavy-duty, modular, vibrating chimes with polished-chrome tone bar and enamel-finished housing. Minimum sound-output rating measured at 10 feet (3 m) shall be 75 dB.
 3. Clock Buzzers: Adjustable output signal device designed for mounting within clock housing or outlet box.
 - a. Sound-Output Rating Measured at 3 Feet (1 m): 75 dB.
 - b. Audible Tone Frequency: Manufacturer's standard between 120 Hz and 2 kHz.
 4. Horns: Modular, adjustable-output, vibrating type with minimum full-intensity-rated sound output of 103 dB measured at 10 feet (3 m).
 5. Projector Horns: Adjustable-output, vibrating type with single **OR** double, **as directed**, projector arranged to channel sound in the direction of the projector axis, and with minimum full-intensity-rated sound output of 104 dB measured at 10 feet (3 m).
 6. Loudspeakers for Audible Tones: See Division 27 Section "Public Address And Mass Notification Systems".
 7. Visible Signal Devices: Strobe lights with blue **OR** yellow, **as directed**, polycarbonate lens and xenon flash tube, with lens mounted on an aluminum faceplate and the word "Program" engraved

in letters at least 1 inch (25 mm) high on lens. Lamp unit shall have a minimum rated light output of 75 candela.

8. Combination Audible and Visible Signal Devices: Factory-integrated horn and strobe light in a single mounting assembly.
9. Outdoor Signal Equipment: Weatherproof models listed for outdoor use.
10. Mounting Arrangement for Signal Devices: Designed for attachment with screws on the mounting plate of a flush-mounted back box unless otherwise indicated.
11. Enclosures for Flush-Mounting Bells and Horns: Enclosure, mounting plate, and grille assembly shall be furnished by device manufacturer to match features of the device to be mounted. Enclosure shall be recessed in wall, completely enclosing the device, with grille mounting over the open side of the enclosure and flush with the wall.
12. Connection Provision for Signal-Indicating Devices: Plug connector **OR** Wire pigtail or compression splice, **as directed**.

F. Clock Circuit Power Booster

1. Description: Transformer power supply, mounted in steel cabinet with hinged door, and having fuse-protected input and output circuits.

G. Back Boxes For Secondary Indicating Clocks And Program Devices

1. Description: Box and cover-plate assembly shall be furnished by device manufacturer and be suitable for device to be mounted. Back boxes shall be equipped with knockouts and hanger straps or mounting adapters arranged for flush mounting the device unless otherwise indicated.

H. Guards

1. Description: Formed-steel wire, shaped to fit around guarded device, with 1-inch (25-mm) maximum clearance.
 - a. Mounting Provisions: Fixed tabs, welded to guard and arranged for screw attachment to mounting surface.
 - b. Finish for Indoor Devices: Clear epoxy lacquer over zinc plating.
 - c. Finish for Outdoor Devices: Black powder coat over zinc plating and primer.

I. Rack-Mounting Provision For Master Clock

1. Equipment Cabinet: Floor **OR** Wall, **as directed**, -mounted, rack type. Comply with EIA-310-D and the following:
 - a. Cabinet Housing: Constructed of steel, with front and rear, **as directed**, doors; with manufacturer's standard tumbler locks, keyed alike.
 - 1) Front door shall have a clear panel in front of the master clock display.
 - 2) Housing shall enclose master clock and auxiliary clock system components, plus a minimum of 20 percent spare capacity for future equipment.
 - b. Forced Ventilation: Internal low-noise fan with a filtered intake vent, connected to operate from 105- to 130-V ac, 60 Hz; separately fused and switchable and arranged to be powered when main cabinet power switch is on.
OR
 Natural Ventilation: Ventilated rear and sides with louvers and solid top.
 - c. For freestanding, floor-mounting cabinet, arrange inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
 - d. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by equipment or panels.
 - e. Finish: Uniform, baked-enamel, manufacturer's standard color finish over rust-inhibiting primer.
 - f. Power-Control Panel: On front of equipment housing; with master power on-off switch and pilot light, and socket for a 5-A, indicating, cartridge fuse for rack equipment power.
 - g. Vertical Plug Strip: Grounded receptacles, 12 inches (300 mm) o.c. the full height of rack, to supply rack-mounting equipment.

- h. Maintenance Receptacles: Duplex convenience outlet with supply terminals separate from equipment plug strip and located in front of rack.

J. Conductors And Cables

- 1. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but not smaller than No. 22 AWG. Voltage drop for signal, control, and clock correction circuits shall not exceed 10 percent under peak load conditions. Comply with requirements in Division 27 Section "Communications Horizontal Cabling".
- 2. 120-V AC and Class 1 Signal and Control Circuits: Stranded, single conductors of size and type recommended by system manufacturer. Materials and installation requirements are specified in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
- 3. Class 2 and Class 3 Signal and Control Circuits: Single conductor or twisted-pair cable, unshielded, unless manufacturer recommends shielded cable.
- 4. Data Circuits: Category 6 minimum, unshielded, twisted-pair cable, unless manufacturer recommends shielded cable.
- 5. Insulation: Thermoplastic, not less than 1/32 inch (0.8 mm) thick.
- 6. Plenum Cable: Listed and labeled for plenum installation.
- 7. Conductor Color-Coding: Uniformly identified and coordinated with wiring diagrams.
- 8. Shielding: For speaker-microphone leads and at other locations recommended by manufacturer; No. 34 AWG tinned, soft-copper strands formed into a braid or equivalent foil.
 - a. Minimum Shielding Coverage on Conductors: 60 percent.

K. Pathways

- 1. Intercommunication and Program System Raceways and Boxes: Comply with requirements in Division 26 Section "Raceway And Boxes For Electrical Systems".
OR
Intercommunication and Program System Raceways and Boxes: Same as required for electrical branch circuits specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
OR
Intercommunication and Program System Raceways and Boxes: Optical fiber/communications raceway and fittings **OR** Metal wireways **OR** Nonmetal wireways **OR** Surface metal raceways **OR** Surface nonmetal raceways, **as directed**.
- 2. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.
- 3. Flexible metal conduit is prohibited.

1.3 EXECUTION

A. Installation

- 1. Mount system components with fastening methods and devices designed to resist the seismic forces indicated in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".

B. Wiring Methods

- 1. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
 - a. Install plenum cable in environmental air spaces, including plenum ceilings.
 - b. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway And Boxes For Electrical Systems".**OR**
Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

2. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
3. Support cables not enclosed in raceways on J-Hooks. Install, size, and space J-Hooks to comply with TIA/EIA-568-B.

C. Electrical Connections

1. Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
2. Use plug connectors **OR** splices, **as directed**, for connections to clocks and signal devices.
3. Ground clocks, programming equipment, and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Identification

1. Comply with Division 26 Section "Identification For Electrical Systems".
2. Color-code wires, and apply wire and cable marking tape to designate wires and cables so they are uniformly identified and coordinated with wiring diagrams throughout the system.

E. 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 operational-system tests to verify compliance with the Specifications and make adjustments to bring system into compliance. Include operation of all modes of clock correction and all programming and manually programmed signal and relay operating functions.
 - b. Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
3. Clock system will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

F. Adjusting

1. Program system according to the Owner's requirements. Set system so signal devices operate on the Owner-required schedules and are activated for durations selected by the Owner. Program equipment-control output circuits to suit the Owner's operating schedule for equipment controlled.
2. Adjust sound-output level of adjustable signal devices to suit the Owner's requirements.
3. 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 Project during other-than-normal occupancy hours for this purpose.

G. Demonstration

1. Train the Owner's maintenance personnel to adjust, operate, and maintain clock-and-program-control system components.

END OF SECTION 27 53 13 13

Task	Specification	Specification Description
27 53 13 16	27 53 13 13	Clock And Program Control

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SECTION 28 16 11 00 - PERIMETER SECURITY

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for perimeter security. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Perimeter detection and alarm system.
 - b. Integration of other electronic and electrical systems and equipment.

C. Definitions

1. CCTV: Closed-circuit television.
2. EMI: Electromagnetic interference.
3. PIR: Passive infrared.
4. RFI: Radio-frequency interference.
5. UPS: Uninterruptible power supply.
6. Control Unit: System component that monitors inputs and controls outputs through various circuits.
7. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.
8. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.
9. Protected Zone: A protected premises or an area within a protected premise that is provided with means to prevent an unwanted event.
10. Standard Intruder: A person who weighs **100 lb (45 kg)** or less and whose height is **60 inches (1525 mm)** or less; dressed in a long-sleeved shirt, slacks, and shoes unless environmental conditions at the site require protective clothing.
11. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.
12. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.
13. Zone. A defined area within a protected premise. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

D. Action Submittals

1. Product Data: Components for sensing, detecting, systems integration, and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
2. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.
 - a. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify programmable logic controllers **OR** networks, **as directed**, and control interface devices and media to be used. Describe characteristics of network and other data communication lines.

- 1) Indicate methods used to achieve systems integration.
- 2) Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
- 3) Describe characteristics of network and other data communication lines.
- 4) Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.
- b. Raceway Riser Diagrams: Detail raceway runs required for perimeter security and for systems integration. Include designation of devices connected by raceway, raceway type, and size, and type and size of wire and cable fill for each raceway run.
- c. UPS: Sizing calculations.
- d. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building. Include room layout for central-station control-unit console, terminal cabinet, racks, and UPS.
- e. Master Control Unit Console Layout: Show required artwork and device identification.
- f. Device Address List: Coordinate with final system programming.
- g. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
- h. Details of surge-protection devices and their installation.
- i. Sensor detection patterns and adjustment ranges.
3. Equipment and System Operation Description: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are not acceptable.
4. Samples for Initial Selection: For units with factory-applied color finishes.
5. Samples for Verification: For each type of exposed finish required.

E. Informational Submittals

1. Qualification Data: For Installer, security systems integrator, and testing agency.
2. Field quality-control test reports.
3. Warranty: Sample of special warranty.
4. Other Information Submittals:
 - a. Test Plan and Schedule: Test plan defining all tests required to ensure that system meets technical, operational, and performance specifications within 60 days of date of Contract award.
 - b. Examination reports documenting inspections of substrates, areas, and conditions.
 - c. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

F. Closeout Submittals

1. Operation and Maintenance Data: For perimeter security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation And Maintenance Data", include the following:
 - a. Data for each type of product, including features and operating sequences, both automatic and manual.
 - b. Master control-unit hardware and software data.

G. Maintenance Material Submittals

1. One spare control-unit board(s) for strain-sensitive cable system and one cable repair and splice kit(s).
2. One of each type of microwave sensor and one of each type of power supply for microwave perimeter security system.
3. One of each spare sensor and PIR unit and one alignment telescope(s) for long-range PIR system.
4. One spare control-unit board(s) for electrostatic-field system.

5. One spare control-unit board(s) for buried, ported coaxial cable system, **10 feet (3 m)** of cable; and one cable repair and splice kit(s).
6. Fuses: Three of each kind and size.
7. Tool Kit: Provide six sets of tools for use with security fasteners, each packaged in a compartmented kit configured for easy handling and storage.
8. Security Fasteners: Furnish no fewer than 1 box for every 50 boxes or fraction thereof, of each type and size of security fastener installed.

H. Quality Assurance

1. Installer Qualifications:
 - a. An employer of workers, at least one of whom is a technician certified by the National Burglar & Fire Alarm Association.
 - b. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Security Systems Integrator Qualifications: An experienced perimeter security equipment supplier and Installer who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
3. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - a. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. FMG Compliance: FMG-approved and -labeled perimeter security devices and equipment.
6. Comply with NFPA 70.

I. Project Conditions

1. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 - a. Altitude: Sea level to **4000 feet (1220 m)**.
 - b. Master Control Unit: Rated for continuous operation in an ambient of **60 to 85 deg F (16 to 29 deg C)** and a relative humidity of 20 to 80 percent, noncondensing.
 - c. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambients of **minus 30 to plus 122 deg F (minus 34 to plus 50 deg C)** dry bulb and 20 to 90 percent relative humidity, condensing. Comply with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to **85 mph (137 km/h)** and snow cover up to **24 inches (610 mm)** thick.
 - d. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings shall be rated, listed, and installed according to NFPA 70.

J. Warranty:

1. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of perimeter security devices and equipment that fail in materials or workmanship within specified warranty period.
 - a. Warranty Period: Two years from date of Final Completion.

1.2 PRODUCTS

A. Functional Description Of System

1. Description: Perimeter protection system with fence-mounted systems **OR** buried sensors **OR** volumetric detectors, **as directed**, integrated into a single perimeter detection and alarm system.
2. Supervision: System components shall be continuously monitored for normal, alarm, supervisory and trouble conditions. Indicate deviations from normal conditions at any location in

- system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.
- a. Alarm Signal: Display at central-station control unit and actuate audible and visual alarm devices.
 - b. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or controller failure.
 - c. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or controller.
3. System Control: Central-station control unit shall directly monitor gate detection devices, perimeter detection units, and connecting wiring.
- OR**
- System Control: One or more remote, addressable controllers operate under control of a central-station control-unit microcomputer in a multiplexed distributed control system or as part of a network. Controllers shall receive programming by multiplexed signal transmission from a central-station control-unit microprocessor or microcomputer and hold data in nonvolatile memory. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance, **as directed**.
4. Operator Commands:
 - a. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
 - b. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
 - c. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
 - d. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
 - e. Protected Zone Test: Initiate operational test of a specific protected zone.
 - f. System Test: Initiate system-wide operational test.
 - g. Print Reports.
 5. Timed Control at Central-Station Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.
 6. Automatic Control of Related Systems: Alarm or supervisory signals from certain perimeter security devices control the following functions in related systems:
 - a. Switch selected lights.
 - b. Open a signal path between certain intercommunication stations.
 - c. Shift sound system to "listening mode" and open a signal path to certain system speakers.
 - d. Switch signal to selected monitor from closed-circuit television camera in vicinity of sensor signaling an alarm.
 7. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When central-station control unit receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands shall initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
 8. Response Time: Two seconds between actuation of any alarm and its indication at central-station control unit.
 9. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, controllers, and sensors from central-station control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at central-station control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.

10. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.
11. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

B. System Component Requirements

1. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit shall be selected and configured with accessories for full compatibility with the existing equipment.
2. Perimeter Security Units: Listed and labeled by a qualified testing agency for compliance with UL 639.
3. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.
 - a. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits".
 - b. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.
4. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V RMS injected into power supply lines at 10 to 10,000 MHz.
5. Tamper Protection: Tamper switches on detection devices, controllers, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Central-station control-unit alarm display shall identify tamper alarms and indicate locations.
6. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to central-station control unit.
7. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to central-station control unit as an alarm signal.
8. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to central-station control unit.
9. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at central-station control unit for calibration, sensitivity, and alarm condition.

C. Enclosures

1. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.
2. Interior Electronics: NEMA 250, Type 12.
3. Exterior Electronics: NEMA 250, Type 4X fiberglass **OR** stainless steel, **as directed**.
4. Corrosion Resistant: NEMA 250, Type 4X PVC **OR** stainless steel, **as directed**.
5. Terminal cabinets in handholes and manholes shall be NEMA 250, Type 6 **OR** 6P, **as directed**.
6. Screw Covers: Where enclosures are accessible to inmates, secure with security fasteners of type appropriate for enclosure.

D. Secure And Access Devices

1. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

2. Key-Operated Switch: Change protected zone between secure and access conditions.

E. Strain-Sensitive Cable

1. Description: Strain-sensitive, coaxial transducer cable shall monitor chain-link-type and welded-mesh-type fence and generate an alarm when a standard intruder attempts to climb over, cut through, or lift fence fabric.
2. Environment: Suitable for exterior installation and the following conditions:
 - a. Ambient Temperatures: Ranging from **minus 22 to plus 158 deg F** (**minus 30 to plus 70 deg C**).
3. Transducer Cable:
 - a. Ultraviolet-resistant cable furnished by system manufacturer.
 - b. Suitable for up to **1000 feet (300 m)** of sensor cable per single-zone controller and up to **2000 feet (600 m)** of sensor cable per dual-zone processor.
 - c. Sensitivity shall be uniform throughout its entire length, requiring only one variable sensitivity adjustment throughout its entire length.
4. Control Unit:
 - a. Field mounted, with tamper switch at controller board.
 - b. Electronic circuitry shall discriminate between acceptable fence movement and intrusion-related disturbances.
 - c. Sensitivity, count control, and climb-over processors shall be adjustable with a minimum of five individual count-control and climb-over adjustments.
 - d. Controller output shall have adjustable pulse width to adjust the time the alarm relay will activate per detected intrusion attempt.
5. System Performance:
 - a. Immune to RFI and EMI environments; interference shall have no effect on normal operational characteristics.
 - b. Trouble and Tamper: Entire sensor system shall be fully supervised with individually monitored tamper and supervision alarms. Disconnecting, cutting, or shorting of strain-sensitive cable results in supervisory alarm.
 - c. Intrusion Simulation: Each zone shall have a self-test feature that, when activated by a signal from central-station control unit, will produce an intrusion alarm and verify operation of sensor.

F. Microwave Intrusion Detectors

1. Description: Volumetric microwave detection system.
2. Device Performance: Microwave transmitter establishes an electromagnetic field in an adjustable detection pattern and detects intrusion by monitoring changes in that pattern.
 - a. Movement Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between **0.1 to 50 fps** (**0.03 to 15.2 m/s**). Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
 - b. Detection range: **15 to 600 feet (5 to 180 m)**.
 - c. Range Sensitivity: Adjustable for setting area of protection between **15 to 500 feet (5 to 152 m)** in range and from **2 to 40 feet (0.6 to 12 m)** in beam diameter.
 - d. Trouble and Tamper: Fully supervised with individually monitored tamper and supervision alarms. System failure shall result in tamper alarm. System jamming or wrong modulation shall result in supervisory alarm.
 - e. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test-enabling switch under sensor housing cover.
 - f. Remote Test: When initiated by central-station control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.
3. Environment: Suitable for exterior installation and the following conditions:

- a. Ambient Temperatures: Ranging from **minus 30 to plus 158 deg F** (minus 34 to plus 70 deg C) and in rainfall up to **4 inches** (100 mm).
- G. Electrostatic Field
1. Description: Electronically balanced phase electrostatic-field detection system consisting of a field generator that generates an electrical field in one or more field wires and that has two or more sensing wires, a sense filter, amplifier, and a controller. Detection fields shall have a minimum of four different frequencies so adjacent zones cannot interfere with each other.
 2. Environment: Suitable for exterior installation and the following conditions:
 - a. Ambient Temperatures: Ranging from **minus 22 to plus 158 deg F** (minus 30 to plus 70 deg C).
 3. System Performance:
 - a. Detect, via sense wires, a compound signal form consisting of amplitude change, rate of change, and pre-set time disturbance that forms a "signature" of human movement. Generate an alarm when all exist simultaneously. Provide detection fields of not less than four different frequencies so adjacent zones do not interfere with each other.
 - b. Control Units: Single or multiple zone, with sense filter. Front panel with calibration meter, status of alarm transmitter, sensitivity selector, test point selector, power indicator, and power control. Control unit shall reject signals due to wind and small objects striking the wires.
 - c. Motion Detection: Sense standard-intruder movement at rates from **0.15 to 26 fps** (0.045 to 8.0 m/s).
 - d. Zone Length: Not to exceed **500 feet** (152 m) **OR 325 feet** (100 m), **as directed**.
 - e. Supervision: Generate trouble signal if field or sense wires are cut or shorted to ground or to each other. Generate supervisory alarm if received signal is substantially reduced.
 4. Insulators, Wire-Tensioning Devices, and Brackets: Manufacturer's standard for mounting and tensioning of wires.
 5. Field and Sensing Wires: Stainless steel.
- H. Buried, Ported Coaxial Cable
1. Description: Buried electrostatic-field detection system consisting of parallel, ported coaxial cables that generate a detection field between cables.
 2. Environment: Suitable for exterior installation and the following conditions:
 - a. Ambient Temperatures: Ranging from **minus 22 to plus 158 deg F** (minus 30 to plus 70 deg C).
 3. System Performance: One of two parallel cables receives a continuous wave signal from a transmitter module. Second cable, connected to a sensor module, detects, preamplifies, and analyzes variations in signal. When system senses "signature" of a standard intruder in the detection zone, based on mass, motion, and time of day, it generates an alarm.
 - a. Transmitter: Locate at one end of zone, with standby battery.
 - b. Preamplifier-Sensor: Locate at opposite end from transmitter, with standby battery.
 - c. Front panel with sensitivity calibration meter, calibrated self-test potentiometer, power switch, and LED normal and malfunction indicators.
 - d. Electromagnetic Radiation: Less than 50 mV per meter at 30 m.
 - e. Motion Detection: Sense standard-intruder movement at rates from **0.17 to 26 fps** (0.05 to 8.0 m/s).
 - f. Zone Length: Not to exceed **500 feet** (152 m) **OR 325 feet** (100 m), **as directed**.
 - g. Zone Width: Not to exceed **15 feet** (4.6 m), with an average width of **12 feet** (3.7 m).
 - h. Zone Height: Approximately **3.3 feet** (1.0 m), depending on sensitivity setting.
 - i. Supervision: Generate trouble signal if cable is cut or shorted to ground. Generate supervisory alarm if cabinets are tampered with.
 4. Enclosures: Hinged cover with tamper switch and security fasteners.
 5. Buried, Ported Coaxial Cable: Approximately **1/2-inch** (1.3-mm) diameter, minimum 10 AWG center conductor, foam polyethylene dielectric, braided copper outer conductor, and polyethylene jacket.

- I. Long-Range PIR Detectors
 - 1. Description: Volumetric passive infrared detection system.
 - 2. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.
 - 3. Environment: Suitable for exterior installation and the following conditions:
 - a. Ambient Temperatures: Ranging from **minus 30 to plus 150 deg F** (minus 34 to plus 65 deg C).
 - 4. System Performance: Detect an interruption of dual-infrared light beams that link transmitters and receivers. Generate an alarm when signal is interrupted due to presence of an object that interrupts both beams.
 - a. Sensitivity: Field adjustable to allow adjustment of range from **25 to 500 feet** (7.6 to 152 m), generating an alarm within 20 to 50 ms when both beams are interrupted.
 - b. Detection system shall adjust automatically to compensate for weather, including fog, rain, snow, blowing dust, and rapid temperature changes.
 - c. Motion Detection: Detect standard-intruder movement at rates from **0.1 to 50 fps** (0.03 to 15.2 m/s).
 - d. Supervision: Generate supervisory alarm if any portion of system is tampered with.
 - e. Remote Test: When initiated by central-station control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.
- J. Geophone Fence Detection
 - 1. Description: Fence-mounted system to detect attempts to cut or climb the protected fence, using geophone sensors that respond to specific shock or vibrations.
 - 2. Environment: Suitable for exterior installation and the following conditions:
 - a. Ambient Temperatures: Ranging from **minus 30 to plus 150 deg F** (minus 34 to plus 65 deg C).
 - 3. System Performance:
 - a. Controller: 10 zone capacity for processing geophone generated analog signals. Each zone shall consist of not more than 10 sensors.
 - 1) Adjustments: For each zone provide stepped gain control for sensitivity, and switches for geophone signal filters to minimize nuisance alarms. System shall adjust automatically to compensate for weather, including fog, rain, snow, blowing dust, and rapid temperature changes.
 - 2) Trouble Condition Signal: Generate when any zone fails.
 - 3) Supervisory Condition Signal: Generate on interference with controller operation or when detecting a break-in into a enclosure housing electronics.
 - b. Sensors: Fence mounted **20 feet** (6 m) o.c.
 - c. Cable for Interconnection of System Components: Shielded, PVC jacketed and armored, as supplied by system manufacturer.
 - d. Test each zone simulating an alarm condition. Test by command from central-station control **OR** test switch at controller inside the enclosure, **as directed**.
- K. Video Motion Sensor
 - 1. Description: Video-surveillance based detection system.
 - 2. Device Performance: Detect changes in video signal within a user-defined protected zone. Provide an alarm output for each video input.
 - a. Detect movement within protected zone of standard intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of 2. Reject all other changes in video signal.
 - b. Modular design that allows for expansion or modification of number of inputs.
 - c. Adjustable Controls:
 - 1) Number of detection zones.
 - 2) Size of detection zones.
 - 3) Sensitivity of detection of each protected zone.
 - d. Mounting: Standard **19-inch** (480-mm) rack as described in EIA 310.

3. Environment: Suitable for installation in interior air-conditioned spaces.

L. Gate Units

1. Description: Fence mounted gate-movement detector, blanced-magnetic type, UL listed for outdoor locations. Units shall be designed for mounting on single- or double-leaf swinging or rolling gates and have armored jumper cables between switch and stationary junction box for wiring to central-station control unit and tamper switches in junction box.
2. Device Performance: Bias magnet and at least three encapsulated-reed switches that resist compromise from introduction of foreign magnetic fields, with integral overcurrent protective device to limit current to 80 percent of switch capacity.
3. Remote Test: Simulate movement of actuating magnet from central-station control unit.

M. Field-Mounted Control Units

1. Field-mounted control units shall include the power supply and detector specific functions, and provide for communications with the master control unit. Control unit shall include read-only resident software needed for startup, a time clock, and all automatic operations. Software shall be downloaded from the master control unit.
2. Battery Backup: UPS, providing 6 hours of run time during a power outage, with 2-rate automatic battery charger to fully recharge batteries within 12 hours after normal power is restored.
 - a. Batteries: Rechargeable, valve-regulated, recombinant, sealed, lead-acid type with nominal 10-year life expectancy.
 - b. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Charger shall recharge fully discharged battery within 24 hours.
3. Annunciation: Indicate a change in system condition and switching of system or component to backup power.

N. Master Control Unit

1. Description: Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.
 - a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 - c. Addressable initiation devices that communicate device identity and status.
 - d. Control circuits for operation of mechanical equipment in response to an alarm.
2. Construction: Freestanding equipment rack **OR** Desk-mounted console, **as directed**, modular, with separate and independent alarm and supervisory system modules. Alarm-initiating protected zone boards shall be plug-in cards. Arrangements that require removal of field wiring for module replacement are unacceptable.
3. Comply with UL 609 **OR** UL 681 **OR** UL 1076, **as directed**.
4. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 - a. Annunciator and Display: LCD type, one **OR** two **OR** three line(s) of 40 **OR** 80 characters, minimum, **as directed**.
 - b. Keypad: Arranged to permit entry and execution of programming, display, and control commands
 - c. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication shall return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures shall identify the failure and record the failure at the annunciator display and at the system printer.
 - d. Field Device Network: Communicate between the control unit and field devices of the system. Communications shall consist of alarm, network status, and status and control of

- field-mounted processors. Each field-mounted device shall be interrogated during each interrogation cycle.
- e. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:
 - 1) Acknowledge alarm.
 - 2) Silence alarm.
 - 3) System reset.
 - 4) LED test.
 - f. Timing Unit: Solid state, programmable, 365 days.
 - g. Confirmation: Relays, contactors, and other control devices shall have auxiliary contacts that provide confirmation signals to system for their on or off status. Software shall interpret such signals, display equipment status, and initiate failure signals.
 - h. Alarm Indication: An audible signal sounds and an LED lights at master control unit identifying the protected zone **OR** addressable detector, **as directed**, originating the alarm. Annunciator panel displays a common alarm light and sounds an audible tone.
 - i. Alarm Indication: An audible signal sounds and a plain-language identification of the protected zone **OR** addressable detector, **as directed** originating the alarm appears on LED or LCD display at master control unit. Annunciator panel displays a common alarm light and sounds an audible tone.
 - j. Alarm Indication: An audible signal sounds and a plain-language identification of the protected zone **OR** addressable detector, **as directed** originating the alarm appears on LED, LCD or cathode-ray-tube display, **as directed** at master control unit. Annunciator panel alarm light and audible tone identify protected zone signaling an alarm.
 - k. Alarm activation sounds a bell **OR** siren **OR** strobe **OR** bell or siren and strobe, **as directed**.
5. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of 25 percent.
 6. Power Supply Circuits: Master control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a 25 percent increase in load.
 7. UPS: Comply with Division 26 Section "Static Uninterruptible Power Supply". UPS shall be sized to provide a minimum of six hours of master control-unit operation.
 8. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than **1 inch (25 mm)** high. Identify, with permanent labels, individual components and modules within cabinets.
 9. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.
 10. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.
- O. Audible And Visual Alarm Devices
1. Bell: UL listed, **10 inches (254 mm)** in diameter, rated to produce a minimum sound output of 84 dB at **10 feet (3 m)** from central-station control unit.
 - a. Enclosure: Weather-resistant steel box equipped with tamper switches on cover and on back of box.

2. Klaxon Weatherproof Motor-Driven Hooter: UL listed, rated to produce a minimum sound output of 120 dB at **3 feet (1 m)**, plus or minus 3 dB, at a frequency of 470 Hz. Rated for intermittent use - two minutes on, five minutes off.
 - a. Designed for use in industrial areas and in high noise, severe weather marine environments.
3. Siren: 30-W speaker with siren driver, rated to produce a minimum sound output of 103 dB at **10 feet (3 m)** from central-station control unit.
 - a. Enclosure: Weather-resistant steel box with tamper switches on cover and on back of box.
4. Strobe: Xenon light complying with UL 1638, with a clear polycarbonate lens.
 - a. Light Output: 115 cd, minimum.
 - b. Flash Rate: 60 per minute.

P. Security Fasteners

1. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.
2. Drive System Types: Pinned Torx-Plus, pinned Torx, or pinned hex (Allen).
3. Socket Flat Countersunk Head Fasteners:
 - a. Heat-treated alloy steel, **ASTM F 835 (ASTM F 835M)**.
 - b. Stainless steel, **ASTM F 879 (ASTM F 879M)**, Group 1 CW.
4. Socket Button Head Fasteners:
 - a. Heat-treated alloy steel, **ASTM F 835 (ASTM F 835M)**.
 - b. Stainless steel, **ASTM F 879 (ASTM F 879M)**, Group 1 CW.
5. Socket Head Cap Fasteners:
 - a. Heat-treated alloy steel, **ASTM A 574 (ASTM A 574M)**.
 - b. Stainless steel, **ASTM F 837 (ASTM F 837M)**, Group 1 CW.
6. Protective Coatings for Heat-Treated Alloy Steel:
 - a. Zinc chromate, ASTM F 1135, Grade 3 or 4; for exterior applications and interior applications where indicated.
 - b. Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide, unless otherwise indicated.

Q. Source Quality Control

1. Electrostatic-Field and Buried, Ported Coaxial Cable Systems Electronics: Precondition at factory by subjecting modules to at least 4 days' operational burn-in at temperatures not less than **140 deg F (60 deg C)**.

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 perimeter security.
2. Examine roughing-in for embedded and built-in anchors to verify actual locations of perimeter security connections before perimeter security installation.
3. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of perimeter security.
4. Inspect built-in and cast-in anchor installations, before installing perimeter security, to verify that anchor installations comply with requirements. Prepare inspection reports.
 - a. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.
 - b. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.
5. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.
6. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Systems Integration

1. Integrate perimeter security system with the following systems and equipment:
 - a. Electronic door hardware.
 - b. Elevators.
 - c. Network lighting controls.
 - d. Intercommunications and program systems.
 - e. Public address and mass notification systems.
 - f. Access control.
 - g. Fire-alarm system.
 - h. Intrusion detection system.
 - i. Video surveillance.

C. System Installation

1. Comply with UL 681 and NFPA 731.
2. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than **72 inches (1830 mm)** above the finished floor.
 - a. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
3. Install wall-mounted equipment, with tops of cabinets not more than **72 inches (1830 mm)** above the finished floor.
 - a. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
4. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.
 - a. Connect new equipment to existing control panel in existing part of the building.
 - b. Connect new equipment to existing monitoring equipment at the Supervising Station.
 - c. Expand, modify, and supplement existing **control** or **monitoring** equipment as necessary to extend existing **control** or **monitoring** functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
5. Security Fasteners: Where accessible to inmates, install perimeter security components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in stainless-steel materials.
6. Wiring Method: Install power, signal, and data transmission wire and cable in raceways according to Division 26 Section(s) "Underground Ducts And Raceways For Electrical Systems" AND "Raceway And Boxes For Electrical Systems". Minimum conduit size shall be **1/2 inch (13 mm)**. Control and data transmission wiring shall not share raceways with any other system.
7. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with perimeter security system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
8. Wires and Cables:
 - a. Conductors: Size as recommended in writing by system manufacturer, unless otherwise indicated.
 - b. 120-V Power Wiring: Install according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables", unless otherwise indicated.
 - c. Cable for Low-Voltage Control and Signal Circuits: Install unshielded, twisted-pair cable, unless otherwise indicated or if manufacturer recommends shielded cable, according to Division 28 Section "Conductors And Cables For Electronic Safety And Security".

- d. Data and Television Signal Transmission Cables: Install according to Division 28 Section "Conductors And Cables For Electronic Safety And Security"
 9. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
 10. Install power supplies and other auxiliary components for detection devices at controllers, unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.
 11. Stain-Sensitive Transducer Cable: Attached to fence at **12-inch (300-mm)** intervals with tie wraps.
 12. Electrostatic-Field System: Install field and sense wires on insulators and standoffs on a fence, wall, or roof. Provide intermediate supports recommended in writing by manufacturer as needed for specified performance.
 13. Buried, Ported Coaxial Cable: Transmitters may be located at one end of parallel coaxial cables, and preamplifier-sensor module may be located at opposite end. Install cable so shield is uniform throughout the length, without twisting or distorting cable during installation. Field-cut cables to exact zone length at the site. To attach data transmission cable to sensing cable, use heat-shrink splice kits approved by manufacturer. Provide sufficient overlap of detector cables to eliminate the possibility of entry between zones.
- D. Identification
1. Identify system components wiring, cabling, and terminals. Comply with identification requirements in Division 26 Section "Identification For Electrical Systems".
 2. Install instructions frame in a location visible from master control unit.
- E. Grounding
1. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.
 2. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
 3. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.
 4. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".
- F. Field Quality Control
1. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
 - a. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.
 2. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections.
 3. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components and equipment installations, including connections.
 4. Tests and Inspections: Comply with provisions in NFPA 731, Ch.9, "Testing and Inspections."
 - a. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
 - b. Operational Tests: Schedule tests after pretesting has been successfully completed. Test all modes of system operation and perimeter security at each detection device. Test for detection of intrusion and for false alarms in each protected zone. Test for false alarms by simulating activities outside indicated detection patterns.
 - c. Electrical Tests: Comply with NFPA 72, Section A-7. Minimum required tests are as follows:

- 1) Verify the absence of unwanted voltages between circuit conductors and ground.
- 2) Test all conductors for short circuits using an insulation-testing device.
- 3) With each circuit pair, short circuit at the far end of circuit and measure circuit resistance with an ohmmeter. Record circuit resistance of each circuit on Record Drawings.
- 4) Verify that each controller is in normal condition as detailed in manufacturer's operation and maintenance manual.
- 5) Test signal and data transmission circuits complying with requirements in Division 28 Section "Conductors And Cables For Electronic Safety And Security" for proper signal transmission under open-circuit conditions. One connection each should be opened at not less than 10 percent of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
- 6) Verify that transient surge-protection devices are installed according to manufacturer's written instructions.
- 7) Test each initiating and indicating device for alarm operation and proper response at central-station control unit.
- 8) Test both primary and secondary power. Verify, by test, that UPS is capable of operating the system for period and in manner specified.
- d. Geophone System Tests: Test each zone at a minimum of two different locations. Test each zone as follows:
 - 1) Horizontal Movement: Adjust sensitivity to screen out alarms from wind.
 - 2) Vertical Climb: 100 percent detection required. Set count at 3 occurrences within 90-second window.
 - 3) Cut Test: 100 percent detection required. Set count at 2 occurrences within 120-second window.
 - 4) Set sensitivity to value as low as possible, consistent with reliable detection.
 - 5) If performance tests fail, make adjustments to sensors to comply with requirements. Retest failing and adjacent zones to comply with test.
- e. Strain-Sensitive Cable System Tests: Adjust sensitivity and count control to value as low as possible, consistent with reliable detection.
- f. Microwave Perimeter Security System Tests: Adjust sensitivity to value as low as possible, consistent with reliable detection.
- g. Long-Range PIR System Tests: Adjust sensitivity and hold time between activity duration to value as low as possible, consistent with reliable detection.
5. Report of Tests and Inspections: Prepare a written record of tests, inspections, and detailed test results in the form of a test log.
6. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.
- G. Demonstration
 1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain perimeter security.
- H. 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 Project during other than normal occupancy hours for this purpose. Visits for this purpose shall be in addition to any required by warranty.

END OF SECTION 28 16 11 00

SECTION 28 16 11 00a - INTRUSION DETECTION

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for intrusion detection. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Intrusion detection with communication links to perform monitoring, alarm, and control functions.
2. Integration of other electronic and electrical systems and equipment.

C. Definitions

1. CCTV: Closed-circuit television.
2. PIR: Passive infrared.
3. RFI: Radio-frequency interference.
4. UPS: Uninterruptible power supply.
5. Control Unit: System component that monitors inputs and controls outputs through various circuits.
6. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.
7. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.
8. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.
9. Standard Intruder: A person who weighs **100 lb (45 kg)** or less and whose height is **60 inches (1525 mm)** or less; dressed in a long-sleeved shirt, slacks, and shoes unless environmental conditions at the site require protective clothing.
10. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.
11. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.
12. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

D. Action Submittals

1. Product Data: Components for sensing, detecting, systems integration, and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
2. Show Drawings: Detail assemblies of standard components that are custom assembled for specific application on the Project.
 - a. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify programmable logic controllers **OR** networks, **as directed** and control interface devices and media to be used. Describe characteristics of network and other data communication lines.

- 1) Indicate methods used to achieve systems integration.
- 2) Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
- 3) Describe characteristics of network and other data communication lines.
- 4) Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.
- b. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection and for systems integration. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.
- c. UPS: Sizing calculations.
- d. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building. Include room layout for master control-unit console, terminal cabinet, racks, and UPS.
- e. Master Control-Unit Console Layout: Show required artwork and device identification.
- f. Device Address List: Coordinate with final system programming.
- g. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
- h. Details of surge-protection devices and their installation.
- i. Sensor detection patterns and adjustment ranges.
3. Equipment and System Operation Description: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.
4. Samples for Initial Selection: For units with factory-applied color finishes.
5. Samples for Verification: For each type of exposed finish required.

E. Information Submittals

1. Qualification Data: For Installer **OR** intrusion detection systems integrator **OR** testing agency, **as directed**.
2. Field quality-control reports.
3. Warranty: Sample of special warranty.
4. Other Information Submittals:
 - a. Test Plan and Schedule: Test plan defining all tests required to ensure that system meets technical, operational, and performance specifications within 60 days of date of Contract award.
 - b. Examination reports documenting inspections of substrates, areas, and conditions.
 - c. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

F. Closeout Submittals

1. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals," include the following:
 - a. Data for each type of product, including features and operating sequences, both automatic and manual.
 - b. Master control-unit hardware and software data.

G. Quality Assurance

1. Installer Qualifications:
 - a. An employer of workers, at least one of whom is a technician certified by the National Burglar & Fire Alarm Association **OR** possess the standards and experience for certification, **as directed**.
 - b. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

2. Intrusion Detection Systems Integrator Qualifications: An experienced intrusion detection equipment supplier and Installer who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
3. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the National Burglar & Fire Alarm Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to Owner's insurance underwriter.
 - a. Testing Agency's Field Supervisor: Person currently certified as an advanced alarm technician by the National Burglar & Fire Alarm Association **OR** possess the standards and experience for certification, **as directed**, to supervise on-site testing specified in Part 3.
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. Control Units, Devices, and Communications with Monitoring Station: Listed and labeled by a qualified testing agency for compliance with SIA CP-01.
6. FM Global Compliance: FMG-Approved and -labeled intrusion detection devices and equipment.
7. Comply with NFPA 70.

H. Project Conditions

1. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 - a. Altitude: Sea level to **4000 feet (1220 m)**.
 - b. Master Control Unit: Rated for continuous operation in an ambient of **60 to 85 deg F (16 to 29 deg C)** and a relative humidity of 20 to 80 percent, noncondensing.
 - c. Interior, Controlled Environment: System components, except master station control unit, installed in air-conditioned **OR** temperature-controlled, **as directed**, interior environments shall be rated for continuous operation in ambients of **36 to 122 deg F (2 to 50 deg C)** dry bulb and 20 to 90 percent relative humidity, noncondensing.
 - d. Interior, Uncontrolled Environment: System components installed in non-air-conditioned **OR** non-temperature-controlled, **as directed**, interior environments shall be rated for continuous operation in ambients of **0 to 122 deg F (minus 18 to plus 50 deg C)** dry bulb and 20 to 90 percent relative humidity, noncondensing.
 - e. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambients of **minus 30 to plus 122 deg F (minus 34 to plus 50 deg C)** dry bulb and 20 to 90 percent relative humidity, condensing. Comply with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to **85 mph (137 km/h)** and snow cover up to **24 inches (610 mm)** thick.
 - f. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings shall be rated, listed, and installed according to NFPA 70.

I. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.
2. Warranty Period: Two years from date of Final Completion.

1.2 PRODUCTS

A. Functional Description Of System

1. Description: Hard-wired **OR** Multiplexed, modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.

2. Supervision: System components shall be continuously monitored for normal, alarm, supervisory, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.
 - a. Alarm Signal: Display at master station control unit and actuate audible and visual alarm devices.
 - b. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or controller failure.
 - c. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or controller.
3. System Control: Master station control unit shall directly monitor intrusion detection units and connecting wiring.
OR
 System Control: Master station control unit shall directly monitor intrusion detection devices, perimeter detection units **OR** controllers associated with perimeter detection units, **as directed**, and connecting wiring in a multiplexed distributed control system or as part of a network.
4. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.
5. Operator Commands:
 - a. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
 - b. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
 - c. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
 - d. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
 - e. Protected Zone Test: Initiate operational test of a specific protected zone.
 - f. System Test: Initiate system-wide operational test.
 - g. Print Reports.
6. Timed Control at Master station control unit: Allow automatically timed "secure" and "access" functions of selected protected zones.
7. Automatic Control of Related Systems: Alarm or supervisory signals from certain intrusion detection devices control the following functions in related systems:
 - a. Switch selected lights.
 - b. Shift elevator control to a different mode.
 - c. Open a signal path between certain intercommunication stations.
 - d. Shift sound system to "listening mode" and open a signal path to certain system speakers.
 - e. Switch signal to selected monitor from closed-circuit television camera in vicinity of sensor signaling an alarm.
8. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When master station control unit receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands shall initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
9. Response Time: Two seconds between actuation of any alarm and its indication at master station control unit.
10. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master station control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at

- master station control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.
11. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.
 12. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.
- B. System Component Requirements
1. Compatibility: Detection devices and their communication features, connecting wiring, and master station control unit shall be selected and configured with accessories for full compatibility with existing equipment:
 2. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.
 - a. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits".
 - b. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.
 3. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.
 4. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V RMS injected into power supply lines at 10 to 10,000 MHz.
 5. Tamper Protection: Tamper switches on detection devices, controllers, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Central-station control-unit alarm display shall identify tamper alarms and indicate locations.
 6. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master station control unit.
 7. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master station control unit as an alarm signal.
 8. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master station control unit.
 9. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master station control unit for calibration, sensitivity, and alarm condition.
- C. Enclosures
1. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.
 2. Interior Electronics: NEMA 250, Type 12.
 3. Exterior Electronics: NEMA 250, Type 4X fiberglass **OR** stainless steel, **as directed**.
 4. Corrosion Resistant: NEMA 250, Type 4X PVC **OR** stainless steel, **as directed**.
 5. Screw Covers: Where enclosures are accessible to inmates, secure with security fasteners of type appropriate for enclosure.
- D. Secure And Access Devices

1. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.
2. Key-Operated Switch: Change protected zone between secure and access conditions.

E. Door And Window Switches

1. Description: Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum of two **OR** three, **as directed**, encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields.
2. Flush-Mounted Switches: Unobtrusive and flush with surface of door and window frame.
3. Overhead Door Switch: Balanced-magnetic type, listed for outdoor locations, and having door-mounting magnet and floor-mounting switch unit.
4. Remote Test: Simulate movement of actuating magnet from master station control unit.

F. PIR Sensors

1. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.
2. Description: Sensors detect intrusion by monitoring infrared wavelengths emitted from a human body within their protected zone and by being insensitive to general thermal variations.
 - a. Wall-Mounting Unit Maximum Detection Range: 125 percent of indicated distance for individual units and not less than **50 feet (15 m)**. Provide adjustable coverage pattern as indicated.
 - b. Ceiling-Mounting Unit Spot-Detection Pattern: Full 360-degree conical.
 - c. Ceiling-Mounting Unit Pattern Size: **84-inch (2135-mm)** diameter at floor level for units mounted **96 inches (2440 mm)** above floor; **18-foot (5.5-m)** diameter at floor level for units mounted **25 feet (7.6 m)** above floor.
3. Device Performance:
 - a. Sensitivity: Adjustable pattern coverage to detect a change in temperature of **2 deg F (1deg C)** or less, and standard-intruder movement within sensor's detection patterns at any speed between **0.3 to 7.5 fps (0.09 to 2.3 m/s)** across 2 adjacent segments of detector's field of view.
 - b. Test Indicator: LED test indicator that is not visible during normal operation. When visible, indicator shall light when sensor detects an intruder. Locate test enabling switch under sensor housing cover.
 - c. Remote Test: When initiated by master station control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

G. Microwave Intrusion Detectors (Interior)

1. Device Performance: Microwave transmitter establishes an electromagnetic field in an adjustable detection pattern and detects intrusion by monitoring changes in that pattern.
 - a. Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between **0.3 to 7.5 fps (0.09 to 2.3 m/s)**. Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
 - b. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test-enabling switch under sensor housing cover.
 - c. Remote Test: When initiated by master station control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

H. Acoustic-Type, Glass-Break Sensors

1. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.
2. Device Performance: Detect unique, airborne acoustic energy spectrum caused by breaking glass.

- a. Sensor Element: Microprocessor-based, digital device to detect breakage of plate, laminate, tempered, and wired glass while rejecting common causes of false alarms. Detection pattern shall be at least a **20-foot (6-m)** range.
 - b. Hookup Cable: Factory installed, not less than **72 inches (1830 mm)**.
 - c. Activation Indicator: LED on sensor housing that lights when responding to vibrations, remaining on until manually reset at sensor controller or at master station control unit.
 - d. Controller: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
 - e. Glass-Break Simulator: A device to induce frequencies into protected glass pane that simulate breaking glass without causing damage to glass.
- I. Piezoelectric-Type, Glass-Break Sensors
- 1. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.
 - 2. Device Performance: Detect unique, high-frequency vibrations caused by breaking glass.
 - a. Sensor Element: Piezoelectric crystals in a housing designed to mount directly to glass surface with adhesive provided by element manufacturer. Circular detection pattern, with at least a **60-inch (1525-mm)** radius on a continuous glass pane. Sensor element shall not be larger than **4 sq. in. (25.80 sq. cm)**.
 - b. Hookup Cable: Factory installed, not less than **72 inches (1830 mm)**.
 - c. Activation Indicator: LED on sensor housing that lights when responding to vibrations, remaining on until manually reset at sensor controller or at master station control unit.
 - d. Controller: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
 - e. Glass-Break Simulator: A device to induce frequencies into protected glass pane that simulate breaking glass without causing damage to glass.
- J. Vibration Sensors
- 1. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.
 - 2. Description: A sensor controller and piezoelectric crystal sensor elements that are designed to be rigidly mounted to structure being protected.
 - 3. Device Performance: Detects high-frequency vibrations generated by use of such tools as oxyacetylene torches, oxygen lances, high-speed drills and saws, and explosives that penetrate a structure while not responding to any other mechanical vibration.
 - a. Circular detection pattern, with at least a **72-inch (1830-mm)** radius on protected structure.
 - b. Hookup Cable: Factory installed, not less than **72 inches (1830 mm)**.
 - c. Controller: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
 - d. Glass-Break Simulator: A device to induce frequencies to protected glass pane that simulate breaking glass without causing damage to glass.
- K. Photoelectric Sensors
- 1. Device Performance: Detect an interruption of a pulsed, infrared, light beam that links transmitter and receiver.
 - a. Sensitivity: Detect standard-intruder movement within sensor's detection patterns at any speed of less than **7.5 fps (2.3 m/s)** though the beam. Allow installation of multiple sensors within same protected zone that will not interfere with each other.
 - b. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
 - c. Remote Test: When initiated by master station control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.
- L. Microwave-PIR Dual-Technology Motion Sensors

1. Description: Single unit combining a sensor that detects changes in microwave signals and a PIR sensor that detects changes in ambient level of infrared emissions caused by standard-intruder movement within detection pattern.
2. Device Performance: An alarm is transmitted when either sensor detects a standard intruder within a period of three to eight seconds from when the other sensor detects a standard intruder.
 - a. Minimum Detection Pattern: A room 20 by 30 feet (6 by 9 m).
 - b. PIR Sensor Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F (1 deg C) or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s) across 2 adjacent segments of detector's field of view.
 - c. Microwave Sensor Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s). Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
 - d. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
 - e. Remote Test: When initiated by master station control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

M. Duress-Alarm Switches

1. Description: A switch with a shroud over the activating lever that allows an individual to covertly send a duress signal to master station control unit, with no visible or audible indication when activated. Switch shall lock in activated position until reset with a key.
 - a. Minimum Switch Rating: 50,000 operations.
 - b. Foot Rail: Foot activated, floor mounting.
 - c. Push Button: Finger activated, suitable for mounting on horizontal or vertical surface.

N. Video Motion Sensor (Interior)

1. Device Performance: Detect changes in video signal within a user-defined protected zone. Video inputs shall be composite video as defined in EIA 170. Provide an alarm output for each video input.
 - a. Detect movement within protected zone of standard intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of 2. Reject all other changes in video signal.
 - b. Modular design that allows for expansion or modification of number of inputs.
 - c. Controls:
 - 1) Number of detection zones.
 - 2) Size of detection zones.
 - 3) Sensitivity of detection of each protected zone.
 - d. Mounting: Standard 19-inch (480-mm) rack as described in EIA 310.

O. Master Control Units

1. Description: Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.
 - a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 - c. Addressable initiation devices that communicate device identity and status.
 - d. Control circuits for operation of mechanical equipment in response to an alarm.
2. Construction: Freestanding equipment rack **OR** Desk-mounted console, **as directed** modular, with separate and independent alarm and supervisory system modules. Alarm-initiating protected

- zone boards shall be plug-in cards. Arrangements that require removal of field wiring for module replacement are unacceptable.
3. Comply with UL 609 **OR** UL 1023 **OR** UL 1076, **as directed**.
 4. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 - a. Annunciator and Display: LCD, one **OR** two **OR** three line(s), as directed of 40 **OR** 80 characters, as directed, minimum.
 - b. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
 - c. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication shall return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures shall identify the failure and record the failure at the annunciator display and at the system printer.
 - d. Field Device Network: Communicate between the control unit and field devices of the system. Communications shall consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device shall be interrogated during each interrogation cycle.
 - e. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:
 - 1) Acknowledge alarm.
 - 2) Silence alarm.
 - 3) System reset.
 - 4) LED test.
 - f. Timing Unit: Solid state, programmable, 365 days.
 - g. Confirmation: Relays, contactors, and other control devices shall have auxiliary contacts that provide confirmation signals to system for their on or off status. Software shall interpret such signals, display equipment status, and initiate failure signals.
 - h. Alarm Indication: Audible signal sounds and a plain-language identification **OR** LED **OR** LCD **OR** cathode ray-tube display at master control unit identifying the protected zone **OR** addressable detector, **as directed** originating the alarm. Annunciator panel displays a common alarm light and sounds an audible tone.
 - i. Alarm activation sounds a bell or siren or strobe **OR** bell or siren and strobe, **as directed**.
 5. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of 25 percent.
 6. Power Supply Circuits: Master station control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a 25 percent increase in load.
 7. UPS: Comply with Division 26 Section "Static Uninterruptible Power Supply". UPS shall be sized to provide a minimum of six hours of central-station control-unit operation.
 8. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than **1 inch (25 mm)** high. Identify, with permanent labels, individual components and modules within cabinets.
 9. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.
 10. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print

system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

P. Audible And Visual Alarm Devices

1. Bell: **10 inches (254 mm)** in diameter, rated to produce a minimum sound output of 84 dB at **10 feet (3 m)** from master control unit.
 - a. Enclosure: Weather-resistant steel box equipped with tamper switches on cover and on back of box.
2. Klaxon Weatherproof Motor-Driven Hooter: UL listed, rated to produce a minimum sound output of 120 dB at **3 feet (1 m)**, plus or minus 3 dB, at a frequency of 470 Hz. Rated for intermittent use: two minutes on and five minutes off.
 - a. Designed for use in industrial areas and in high-noise, severe-weather marine environments.
3. Siren: 30-W speaker with siren driver, rated to produce a minimum sound output of 103 dB at **10 feet (3 m)** from master control unit.
 - a. Enclosure: Weather-resistant steel box with tamper switches on cover and on back of box.
4. Strobe: Xenon light complying with UL 1638, with a clear polycarbonate lens.
 - a. Light Output: 115 cd, minimum.
 - b. Flash Rate: 60 per minute.

Q. Security Fasteners

1. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.
2. Drive System Types: Pinned Torx-Plus **OR** pinned Torx **OR** pinned hex (Allen), **as directed**.
3. Socket Flat Countersunk Head Fasteners:
 - a. Heat-treated alloy steel, **ASTM F 835 (ASTM F 835M)**.
 - b. Stainless steel, **ASTM F 879 (ASTM F 879M)**, Group 1 CW.
4. Socket Button Head Fasteners:
 - a. Heat-treated alloy steel, **ASTM F 835 (ASTM F 835M)**.
 - b. Stainless steel, **ASTM F 879 (ASTM F 879M)**, Group 1 CW.
5. Socket Head Cap Fasteners:
 - a. Heat-treated alloy steel, **ASTM A 574 (ASTM A 574M)**.
 - b. Stainless steel, **ASTM F 837 (ASTM F 837M)**, Group 1 CW.
6. Protective Coatings for Heat-Treated Alloy Steel:
 - a. Zinc chromate, ASTM F 1135, Grade 3 or Grade 4, for exterior applications and interior applications where indicated.
 - b. Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide unless otherwise indicated.

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 intrusion detection.
2. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.
3. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.
4. Inspect built-in and cast-in anchor installations, before installing intrusion detection, to verify that anchor installations comply with requirements. Prepare inspection reports.
 - a. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.

- b. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.
 5. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.
 6. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. System Integration
 1. Electronic door hardware.
 2. Elevators.
 3. Network lighting controls.
 4. Intercommunications and program systems.
 5. Public address and mass notification systems.
 6. Access control.
 7. Fire-alarm system.
 8. Perimeter security system.
 9. Video surveillance.
- C. System Installation
 1. Comply with UL 681 and NFPA 731.
 2. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than **72 inches (1830 mm)** above the finished floor.
 - a. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
 3. Install wall-mounted equipment, with tops of cabinets not more than **72 inches (1830 mm)** above the finished floor.
 - a. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
 4. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.
 - a. Connect new equipment to existing control panel in existing part of the building.
 - b. Connect new equipment to existing monitoring equipment at the Supervising Station.
 - c. Expand, modify, and supplement existing control **OR** monitoring equipment, **as directed** as necessary to extend existing control **OR** monitoring functions, **as directed** to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
 5. Security Fasteners: Where accessible to inmates, install intrusion detection components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in stainless-steel materials.
- D. Wiring Installation
 1. Wiring Method: Install wiring in metal raceways according to Division 26 Section "Raceway And Boxes For Electrical Systems". Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be **1/2 inch (13 mm)**. Control and data transmission wiring shall not share conduit with other building wiring systems.
 2. Wiring Method: Install wiring in raceways except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be **1/2 inch (13 mm)**. Control and data transmission wiring shall not share conduit with other building wiring systems.
 3. Wiring Method: Cable, concealed in accessible ceilings, walls, and floors when possible.
 4. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according

to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

5. Wires and Cables:

- a. Conductors: Size as recommended in writing by system manufacturer, unless otherwise indicated.
- b. 120-V Power Wiring: Install according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables", unless otherwise indicated.
- c. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable, unless otherwise indicated or if manufacturer recommends shielded cable, according to Division 28 Section "Conductors And Cables For Electronic Safety And Security".
- d. Data and Television Signal Transmission Cables: Install according to Division 28 Section "Conductors And Cables For Electronic Safety And Security".

6. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

7. Install power supplies and other auxiliary components for detection devices at controllers, unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

8. Identify components with engraved, laminated-plastic or metal nameplate for master station control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification For Electrical Systems".

E. Identification

1. Identify system components, wiring, cabling, and terminals. Comply with identification requirements as specified in Division 26 Section "Identification For Electrical Systems".
2. Install instructions frame in a location visible from master control unit.

F. Grounding

1. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.
2. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
3. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.
4. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".

G. Field Quality Control

1. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
 - a. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.
2. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections.
3. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect test, and adjust components, assemblies, and equipment installations connections.
4. 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.
5. Test and Inspections: Comply with provisions in NFPA 731, Ch.9, "Testing and Inspections."

- a. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
 - b. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."
 6. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."
 7. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.
 - 8.
- H. Adjusting
1. Occupancy Adjustments: When requested within 12 months of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose. Visits for this purpose shall be in addition to any required by warranty.
- I. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain intrusion detection system. Comply with documentation provisions in NFPA 731, Ch.4, "Documentation and User Training."

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Task	Specification	Specification Description
28 16 11 00	27 51 23 50	Educational Intercommunications and Program Systems
28 16 11 00	26 33 43 00b	Public Address and Mass Notification Systems

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SECTION 28 21 31 00 - VIDEO SURVEILLANCE

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for video surveillance. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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 video surveillance system consisting of cameras, digital video recorder, data transmission wiring, and a control station with its associated equipment.
2. Video surveillance system shall be integrated with monitoring and control system specified in Division 13 Section "Perimeter Security", "Intrusion Detection", "Security Access", and PLC Electronic Detention Monitoring and Control Systems", which specifies systems integration.

C. Definitions

1. AGC: Automatic gain control.
2. BNC: Bayonet Neill-Concelman - type of connector.
3. B/W: Black and white.
4. CCD: Charge-coupled device.
5. FTP: File transfer protocol.
6. IP: Internet protocol.
7. LAN: Local area network.
8. MPEG: Moving picture experts group.
9. NTSC: National Television System Committee.
10. PC: Personal computer.
11. PTZ: Pan-tilt-zoom.
12. RAID: Redundant array of independent disks.
13. TCP: Transmission control protocol - connects hosts on the Internet.
14. UPS: Uninterruptible power supply.
15. WAN: Wide area network.

D. Performance Requirements

1. Seismic Performance: Video surveillance system 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."

E. Submittals

1. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
2. Shop Drawings: For video surveillance. 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. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
 - c. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
 - d. UPS: Sizing calculations.
 - e. Wiring Diagrams: For power, signal, and control wiring.

3. **Equipment List:** Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.
4. **Seismic Qualification Certificates:** For video surveillance, cameras, camera-supporting equipment, 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.
 - d. **Field quality-control reports.**
 - e. **Operation and Maintenance Data:** For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. Include the following:
 - 1) Lists of spare parts and replacement components recommended to be stored at the site for ready access.
5. **Warranty:** Sample of special warranty.

F. 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 NECA 1.**
3. **Comply with NFPA 70.**
4. **Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.**

G. Project Conditions

1. **Environmental Conditions:** Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 - a. **Control Station:** Rated for continuous operation in ambient temperatures of **60 to 85 deg F (16 to 29 deg C)** and a relative humidity of 20 to 80 percent, noncondensing.
 - b. **Interior, Controlled Environment:** System components, except central-station control unit, installed in air-conditioned **OR** temperature-controlled, **as directed**, interior environments shall be rated for continuous operation in ambient temperatures of **36 to 122 deg F (2 to 50 deg C)** dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
 - c. **Interior, Uncontrolled Environment:** System components installed in non-air-conditioned **OR** non-temperature-controlled, **as directed**, interior environments shall be rated for continuous operation in ambient temperatures of **0 to 122 deg F (minus 18 to plus 50 deg C)** dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 3R **OR** Type 4 **OR** Type 12 **OR** Type 12K, **as directed**, enclosures.
 - d. **Exterior Environment:** System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of **minus 30 to plus 122 deg F (minus 34 to plus 50 deg C)** dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to **85 mph (137 km/h)** and snow cover up to **24 inches (610 mm)** thick, **as directed**. Use NEMA 250, Type 3 **OR** Type 3R **OR** Type 3S **OR** Type 4 **OR** Type 4X, **as directed**, enclosures.
 - e. **Hazardous Environment:** System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.

- f. Corrosive Environment: System components subject to corrosive fumes, vapors, and wind-driven salt spray in coastal zones. Use NEMA 250, Type 4X **OR** Type 6P, **as directed**, enclosures.
- g. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

H. Warranty

- 1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.
 - a. Warranty Period: Three years from date of Final Completion.

1.2 PRODUCTS

A. System Requirements

- 1. Video-signal format shall comply with NTSC standard, composite interlaced video. Composite video-signal termination shall be 75 ohms.
- 2. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.
 - a. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Division 16 Section "Transient Voltage Suppression."
 - b. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Division 16 Section "Transient Voltage Suppression" as recommended by manufacturer for type of line being protected.
- 3. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

B. Standard Cameras

- 1. B/W Camera:
 - a. Comply with UL 639.
 - b. Pickup Device: CCD interline transfer, 252,000 512(H) by 492(V) pixels, **unless directed otherwise**.
 - c. Horizontal Resolution: 380 lines.
 - d. Signal-to-Noise Ratio: Not less than 46 dB.
 - e. With AGC, manually selectable on or off.
 - f. Sensitivity: Camera shall provide usable images in low-light conditions, delivering an image at a scene illumination, as directed by the Owner, with camera AGC off, **as directed**.

OR

Sensitivity: Camera shall deliver 1-V peak-to-peak video signal at the minimum specified light level. Illumination for the test shall be with lamps rated at approximately 2200-K color temperature, and with camera AGC off.

 - g. Manually selectable modes for backlight compensation or normal lighting.
 - h. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera shall revert to internally generated synchronization on loss of external synch signal.
 - i. Motion Detector: Built-in digital.
- 2. Color Camera:
 - a. Comply with UL 639.
 - b. Pickup Device: CCD interline transfer, 380,000 771(H) by 492(V) pixels, **unless directed otherwise**.
 - c. Horizontal Resolution: 480 lines.
 - d. Signal-to-Noise Ratio: Not less than 50 dB, with camera AGC off.

- e. With AGC, manually selectable on or off.
- f. Sensitivity: Camera shall provide usable images in low-light conditions, delivering an image at a scene illumination, as directed by the Owner, with camera AGC off, **as directed.**
OR
 Sensitivity: Camera shall deliver 1-V peak-to-peak video signal at the minimum specified light level. Illumination for the test shall be with lamps rated at approximately 2200-K color temperature, and with camera AGC off.
- g. Manually selectable modes for backlight compensation or normal lighting.
- h. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera shall revert to internally generated synchronization on loss of external synch signal.
- i. White Balance: Auto-tracing white balance, with manually settable fixed balance option.
- j. Motion Detector: Built-in digital.
- 3. Automatic Color Dome Camera: Assembled and tested as a manufactured unit, containing dome assembly, color camera, motorized pan and tilt, zoom lens, and receiver/driver.
 - a. Comply with UL 639.
 - b. Pickup Device: CCD interline transfer, 380,000 768(H) by 494(V) pixels, **unless directed otherwise.**
 - c. Horizontal Resolution: 480 lines.
 - d. Signal-to-Noise Ratio: Not less than 50 dB, with camera AGC off.
 - e. With AGC, manually selectable on or off.
 - f. Sensitivity: Camera shall provide usable images in low-light conditions, delivering an image at a scene illumination, as directed by the Owner, with camera AGC off, **as directed.**
OR
 Sensitivity: Camera shall deliver 1-V peak-to-peak video signal at the minimum specified light level. Illumination for the test shall be with lamps rated at approximately 2200-K color temperature, and with camera AGC off.
 - g. Manually selectable modes for backlight compensation or normal lighting.
 - h. Pan and Tilt: Direct-drive motor, 360-degree rotation angle, and 180-degree tilt angle. Pan-and-tilt speed shall be controlled by operator. Movement from preset positions shall be not less than 300 degrees per second.
 - i. Preset Positioning: Eight user-definable scenes, each allowing 16-character titles. Controls shall include the following:
 - 1) In "sequence mode," camera shall continuously sequence through preset positions, with dwell time and sequencing under operator control.
 - 2) Motion detection shall be available at each camera position.
 - 3) Up to four preset positions may be selected to be activated by an alarm. Each of the alarm positions may be programmed to output a response signal.
 - j. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera shall revert to internally generated synchronization on loss of external synch signal.
 - k. White Balance: Auto-tracing white balance, with manually settable fixed balance option.
 - l. Motion Detector: Built-in digital.
 - m. Dome shall support multiplexed control communications using coaxial cable recommended by manufacturer.

C. Submersible Cameras

- 1. Camera: Color, designed for underwater monitoring and for inspecting pipes and storm drains. Attributes as follows:
 - a. Infrared LEDs to provide illumination in zero-light conditions.
 - b. **60-foot (18.3-m)** factory-installed cable with BNC connector for video and a 2.1-mm jack for 12-V dc power supply.
 - c. An adjustable swivel mount and attachment base.
 - d. Pickup Device: CCD interline transfer, 290,000 500(H) by 580(V) pixels, **unless directed otherwise.**

- e. Horizontal Resolution: 380 lines.
 - f. Signal-to-Noise Ratio: Not less than 50 dB.
 - g. With AGC, from 4 to 39 dB.
 - h. Sensitivity: Camera shall provide usable images in low-light conditions, delivering an image at a scene illumination of 0.1 lux at f/2.0.
 - i. Scanning Synchronization: Internal.
 - j. White Balance: Auto-tracing white balance, for colors ranging from 2800 to 8200 deg K.
- D. Reinforced Dome Cameras
- 1. Camera: Designed for high-abuse locations, with a weathertight semirecessed **OR** surface, **as directed**, mounting, impact-resistance polycarbonate dome, and heavy-gage, 6061 T6 aluminum body.
 - a. Suitable for exterior environment, rated for continuous operation in ambient temperatures of **minus 40 to plus 122 deg F (minus 40 to plus 50 deg C)** dry bulb and up to 85 percent relative humidity.
 - b. Pickup Device: CCD interline transfer, 290,000 510(H) by 492(V) pixels, **unless directed otherwise**.
 - c. Horizontal Resolution: 350 lines.
 - d. Signal-to-Noise Ratio: Not less than 46 dB.
 - e. With AGC and automatic backlight compensation.
 - f. Sensitivity: Camera shall provide usable images in low-light conditions, delivering an image at a scene illumination of 6 lux at f/2.0.
 - g. Scanning Synchronization: Determined by external synch over the coaxial cable. Camera shall revert to internally generated synchronization on loss of external synch signal.
 - h. White Balance: Auto-tracing white balance.
- E. Lenses
- 1. Description: Optical-quality coated lens, designed specifically for video-surveillance applications and matched to specified camera. Provide color-corrected lenses with color cameras.
 - a. Auto-Iris Lens: Electrically controlled iris with circuit set to maintain a constant video level in varying lighting conditions.
 - b. Fixed Lens: With calibrated focus ring.
 - c. Zoom Lens: Motorized, remote-controlled unit, rated as "quiet operating." Features include the following:
 - 1) Electrical Leads: Filtered to minimize video signal interference.
 - 2) Motor Speed: Variable.
 - 3) Lens shall be available with preset positioning capability to recall the position of specific scenes.
- F. Power Supplies
- 1. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera, infrared illuminator, **as directed**, and lens.
 - a. Enclosure: NEMA 250, Type 1 **OR** Type 3 **OR** Type 4X, **as directed**.
- G. Infrared Illuminators
- 1. Description: Lighting fixtures that emit light only in the infrared spectrum, suitable for use with cameras indicated, for nighttime surveillance, without emitting visible light.
 - a. Field-Selectable Beam Patterns: Narrow, medium, and wide.
 - b. Rated Lamp Life: More than 8000 hours.
 - c. Power Supply: 12-V ac/dc **OR** 120-V ac, **as directed**.
 - 2. Area Coverage: Illumination to **150 feet (50 m)** in a narrow beam pattern.
 - 3. Exterior housings shall be suitable for same environmental conditions as the associated camera.
- H. Camera-Supporting Equipment

1. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.
2. Pan Units: Motorized automatic-scanning units arranged to provide remote-controlled manual and automatic camera panning action, and equipped with matching mounting brackets.
 - a. Scanning Operation: Silent, smooth, and positive.
 - b. Stops: Adjustable without disassembly, to limit the scanning arc.
3. Pan-and-Tilt Units: Motorized units arranged to provide remote-controlled aiming of cameras with smooth and silent operation, and equipped with matching mounting brackets.
 - a. Panning Rotation: 0 to 355 degrees, with adjustable stops.
 - b. Tilt Movement: 90 degrees, plus or minus 5 degrees, with adjustable stops.
 - c. Speed: 12 degrees per second in both horizontal and vertical planes.
 - d. Wiring: Factory prewired for camera and zoom lens functions and pan-and-tilt power and control.
 - e. Built-in encoders or potentiometers for position feedback, and thermostat-controlled heater, **as directed**.
 - f. Pan-and-tilt unit shall be available with preset positioning capability to recall the position of a specific scene.
4. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.
5. Protective Housings for Fixed and Movable Cameras: Steel or 6061 T6 aluminum, **as directed**, enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and mounting and installing arrangement of camera to be housed.
 - a. Tamper switch on access cover sounds an alarm signal when unit is opened or partially disassembled. Central-control unit shall identify tamper alarms and indicate location in alarm display. Tamper switches and central-control unit are specified in Division 13 Section "Intrusion Detection."
 - b. Camera Viewing Window: Polycarbonate **OR** Lexan, **as directed**, window, aligned with camera lens.
 - c. Duplex Receptacle: Internally mounted.
 - d. Alignment Provisions: Camera mounting shall provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.
 - e. Built-in, thermostat-activated heater and blower units. Units shall be automatically controlled so the environmental limits of the camera equipment are not exceeded.
 - f. Sun shield shall not interfere with normal airflow around the housing.
 - g. Mounting bracket and hardware for wall or ceiling mounting of the housing. Bracket shall be of same material as the housing; mounting hardware shall be stainless steel.
 - h. Finish: Housing and mounting bracket shall be factory finished using manufacturer's standard finishing process suitable for the environment.
 - i. Enclosure Rating: as directed by the Owner.

I. Monitors

1. Monochrome:
 - a. Metal cabinet units designed for continuous operation.
 - b. Screen Size (Diagonal Dimension): as directed by the Owner.
 - c. Horizontal Resolution: 600 lines, minimum, at center.
 - d. Minimum Front Panel Devices and Controls: Power switch; power-on indicator; and brightness, horizontal-hold, vertical-hold, and contrast controls.
 - e. Mounting: Adjustable tilting and training.
 - f. Mounting: Single, **14-inch (356-mm)** **OR** Dual, **9-inch (229-mm)**, **as directed**, vertical, EIA **19-inch (483-mm)** electronic equipment rack or cabinet complying with CEA 310-E.
 - g. Electrical: 120-V ac, 60 Hz.
2. Color:
 - a. Metal cabinet units designed for continuous operation.
 - b. Screen Size (Diagonal Dimension): as directed by the Owner.
 - c. Horizontal Resolution: 300 lines.

- d. Minimum Front Panel Devices and Controls: Power switch; power-on indicator; and brightness, contrast, color, and tint controls.
 - e. Degaussing: Automatic.
 - f. Mounting: Single, **14-inch (356-mm)** OR Dual, **9-inch (229-mm)**, **as directed**, vertical, EIA **19-inch (483-mm)** electronic equipment rack or cabinet complying with CEA 310-E.
 - g. Electrical: 120-V ac, 60 Hz.
- J. Videotape Recorders
- 1. Description: Industrial, time-lapse type recorder, designed for continuous operation. Tape format is **1/2 inch (13 mm)** using industrial-grade, T-120 cassettes.
 - a. Horizontal Resolution: 400 lines, minimum.
 - b. Recording Heads: Rotary-scan type.
 - c. Integral Timer: Permits programming of recording operation for adjustable daily and weekly periods.
 - d. Time-Lapse Operating Modes: Multiple, covering 24 to 240 hours, minimum.
 - e. Other Operating Modes:
 - 1) Manual play and recording at two- and six-hour speeds.
 - 2) Forward and reverse high-speed search.
 - 3) Reverse, slow, and single-frame play.
 - f. Alarm Recording: Operating mode is automatically switched from time-lapse to two- or six-hour recording mode when an externally generated alarm signal is received.
 - g. Audio Recording: 70 to 7000 Hz. Phono and microphone input; phono output.
 - h. Time and Date Generator: Records time and date legend in corner of recorded scenes.
 - i. Tape Counter: Displays tape position.
 - j. Manual Recording Lock: Key or keypad operated. Prevents unauthorized tampering or control changes during preset operation.
 - k. Signal-to-Noise Ratio: 45 dB for video output in standard play mode.
 - l. Mounting: Standard **19-inch (483-mm)** rack complying with CEA 310-E, or freestanding desktop.
- K. Digital Video Recorders
- 1. Description: Digital, time-lapse type, full-frame and motion recorder, with removable hard drive.
 - a. Recording Time: 400 hours minimum.
 - b. Resolution: 720 by 480 lines, minimum.
 - c. Programming shall be from trackball and push buttons on face of the recorder, settings shall be displayed on any video monitor connected to the recorder. Programming shall include the following:
 - 1) Motion analysis graph.
 - 2) Password protection.
 - 3) Alarm and timer controls.
 - 4) Continuous recording option.
 - 5) Time-lapse operating modes.
 - 6) Search video by time, event, or motion.
 - d. Programming: SmartMedia card for software updating, image archiving, and image transfer to a PC.
 - e. Storage: 80-GB, **unless directed otherwise**, removable hard drive. Software shall permit hot-swapping drives.
 - f. Compression: MPEG-2.
 - g. Time and Date Generator: Records time (hr:min:sec) and date legend of each frame.
 - h. Audio Recording: 70 to 7000 Hz. Phono and microphone input; phono output.
 - i. Mounting: Standard **19-inch (483-mm)** rack complying with CEA 310-E, or freestanding desktop.
- L. Network Video Recorders
- 1. External storage or internal 250-1, 500-GB hard disk drive.
 - a. Video and audio recording over TCP/IP network.

- b. Video recording of MPEG-2 and MPEG-4 streams.
- c. Video recording up to 48 Mbps for internal storage and up to 100 Mbps for external storage.
- d. Duplex Operation: Simultaneous recording and playback.
- e. Continuous and alarm-based recording.
- f. Full-Featured Search Capabilities: Search based on camera, time, or date.
- g. Automatic data replenishment to ensure recording even if network is down.
- h. Digital certification by watermarking.
- i. Internal RAID storage or non-RAID storage of up to 1500 GB.
- j. Capable of adding external RAID storage up to 7000 GB for models with no internal storage.
- k. Full integration with LAN, Intranet, or Internet through standard Web browser or video management software.
- l. Integrated Web server FTP server functionality.
- m. Supports up to 16, 32, or 64 devices.

M. Digital Switchers

1. Quad Switch: For displaying images from four cameras on a single monitor. Provide color switcher if one or more cameras or monitors are in color.
 - a. Controls: Unit-mounted front panel.
 - b. Resolution: 720 by 480 lines, **unless directed otherwise**.
 - c. Modes: Auto, manual, and alarm. In manual mode, each channel can also be viewed in single display mode. In the event of an alarm, alarming channel shall automatically switch to full screen. If several alarms are activated, channels in alarm shall be in auto-switching mode.
 - d. Channel Loss Alarm: Audible buzzer; occurrence details shall be recorded.
 - e. Time: Indicate date and time.
 - f. Timing of Auto-Switcher: 1 to 30 seconds, selectable.
 - g. Mounting: Standard **19-inch (483-mm)** rack complying with CEA 310-E, or freestanding desktop.
2. Manual Switch Bank: Low-loss, high-isolation, multiple-video switch to allow manual switching of multiple quad switches and cameras to a single output. Switches shall be illuminated.
3. Sequential Switchers: Automatically sequence outputs of multiple cameras to single monitor and videotape recorder.
 - a. Switching Time Interval: Continuously adjustable, 5 to 20 seconds minimum, with manual override.
 - b. Skip-Sequential-Hold Switch: One for each camera, with LED to indicate active camera.
 - c. Camera Identification Legend: Either on-screen message or label at skip-sequential switch.
 - d. Alarm Switching: In the event of an alarm, alarming channel shall automatically switch the monitor to full screen.
 - e. Mounting: Standard **19-inch (483-mm)** rack complying with CEA 310-E.
4. PTZ Controls: Arranged for multiple-camera control, with switches to select camera to be controlled.
 - a. Pan-and-Tilt Control: Joystick type.
 - b. Zoom Control: Momentary-contact, "in-out" push button.
 - c. Automatic-Scan Control: A push button for each camera with pan capability that places camera in automatic-scanning mode.

N. IP Video Systems

1. Description:
 - a. System shall provide high-quality delivery and processing of IP-based video, audio, and control data using standard Ethernet-based networks.
 - b. System shall have seamless integration of all video surveillance and control functions.

- c. Graphical user interface software shall manage all IP-based video matrix switching and camera control functions, two-way audio communication, alarm monitoring and control, and recording and archive/retrieval management. IP system shall also be capable of integrating into larger system environments.
 - d. System design shall include all necessary compression software for high-performance, dual-stream, MPEG-2/MPEG-4 video. Unit shall provide connections for all video cameras, camera PTZ control data, bidirectional audio, discreet sensor inputs, and control system outputs.
 - e. All camera signals shall be compressed, encoded, and delivered onto the network for processing and control by the IP video-management software.
 - f. Camera system units shall be ruggedly built and designed for extreme adverse environments, complying with NEMA Type environmental standards.
 - g. Encoder/decoder combinations shall place video, audio, and data network stream that can be managed from multiple workstations on the user's LAN or WAN.
 - h. All system interconnect cables, workstation PCs, PTZ joysticks, and network intermediate devices shall be provided for full performance of specified system.
- O. Video Motion Sensors (Interior)
 - 1. Device Performance: Detect changes in video signal within a user-defined protected zone. Video inputs shall be composite video as defined in SMPTE 170M. Provide an alarm output for each video input.
 - a. Detect movement within protected zone of intruders wearing clothing with a reflectivity that differs from that of background scene by a factor of two. Reject all other changes in video signal.
 - b. Modular design that allows for expansion or modification of number of inputs.
 - c. Controls:
 - 1) Size of detection zones.
 - 2) Sensitivity of detection of each protected zone.
 - d. Mounting: Standard 19-inch (483-mm) rack complying with CEA 310-E.
- P. Control Stations
 - 1. Description: Heavy-duty, freestanding, modular, metal furniture units arranged to house electronic equipment. Coordinate component arrangement and wiring with components and wiring of other systems.
 - 2. Equipment Mounting: Standard 19-inch (483-mm) rack complying with CEA 310-E.
 - 3. Normal System Power Supply: 120 V, 60 Hz, through a locked disconnect device and an isolation transformer in central-station control unit. Central-station control unit shall supply power to all components connected to it unless otherwise indicated.
 - 4. Power Continuity for Control Station: Batteries in power supplies of central-station control units and individual system components shall maintain continuous system operation during outages of both normal and backup ac system supply.
 - a. Batteries: Rechargeable, valve-regulated, recombinant, sealed, lead-acid type with nominal 10-year life expectancy. Capacity adequate to operate portions of system served including audible trouble signal devices for up to four hours and audible and visual alarm devices under alarm conditions for an additional 10 minutes.
 - b. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Charger shall recharge fully discharged battery within 24 hours.
 - 5. Annunciation: Indicate change in system condition and switching of system or component to backup power.
- Q. Signal Transmission Components
 - 1. Cable: Coaxial cable elements have 75-ohm nominal impedance. Comply with requirements in Division 16 Section "Conductors and Cables for Electronic Safety and Security."
 - 2. Video Surveillance Coaxial Cable Connectors: BNC type, 75 ohms. Comply with requirements in Division 16 Section "Conductors and Cables for Electronic Safety and Security."

1.3 EXECUTION

A. Examination

1. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.
2. Examine roughing-in for LAN, WAN, and IP network before device installation.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Wiring

1. Comply with requirements in Division 16 Section "Raceways and Boxes."

OR

Wiring Method: Install cables in raceways unless otherwise indicated.

- a. Except raceways are not required in accessible indoor ceiling spaces and attics.

OR

Except raceways are not required in hollow gypsum board partitions.

- b. Conceal raceways and wiring except in unfinished spaces.
2. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
3. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
4. For LAN connection and fiber-optic and copper communication wiring, comply with Division 16 Sections "Communications Backbone Cabling" and "Communications Horizontal Cabling."
5. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

C. Video Surveillance System Installation

1. Install cameras and infrared illuminators level and plumb.
2. Install cameras with ~~84-inch-~~ (2134-mm-) minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.
3. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.
4. Install power supplies and other auxiliary components at control stations unless otherwise indicated.
5. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.
6. Avoid ground loops by making ground connections only at the control station.
 - a. For 12- and 24-V dc cameras, connect the coaxial cable shields only at the monitor end.
7. Identify system components, wiring, cabling, and terminals according to Division 16 Section "Electrical Identification."

D. Field Quality Control

1. Perform tests and inspections.
2. Tests and Inspections:
 - a. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
 - b. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
 - 1) Prepare equipment list described in "Submittals" Article.

- 2) Verify operation of auto-iris lenses.
- 3) Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
- 4) Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object **50 to 75 feet (17 to 23 m)** away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
- 5) Set and name all preset positions; consult Owner's personnel.
- 6) Set sensitivity of motion detection.
- 7) Connect and verify responses to alarms.
- 8) Verify operation of control-station equipment.
- c. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
- d. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
3. Video surveillance system will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

E. 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 Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:
 - a. Check cable connections.
 - b. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
 - c. Adjust all preset positions; consult Owner's personnel.
 - d. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
 - e. Provide a written report of adjustments and recommendations.

F. Cleaning

1. Clean installed items using methods and materials recommended in writing by manufacturer.
2. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

G. Demonstration

1. Train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

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SECTION 28 42 11 00 - UNDERGROUND STORAGE TANKS

1.1 GENERAL

A. Description Of Work

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

B. Intent of Work

1. It is the intent of this specification to ensure that the work, as completed, shall meet or exceed all applicable codes, ordinances, rules and regulations of every authority having jurisdiction in the area.
2. The installation shall include all necessary equipment, controls, valves and fittings, excavation, backfill as described or called for on the plans. In some cases, the Contractor shall prepare the plans. In any case, the Contractor shall obtain all permits at its expense.
3. The Contractor shall install equipment in accordance with manufacturer's recommendations. Where drawings (if any) and specification conflict with manufacturer's recommendations, it shall be the Contractor's responsibility to bring this to the attention of the Owner before installation.
4. The overall intent shall be that the Contractor shall provide everything required to make a complete and operational job in every respect.

C. Codes And Standards

1. Reference is to the latest edition of the code or standard unless otherwise noted. Comply with the latest EPA requirements.
2. The codes and standards referred to are the minimum standards. Where the requirements of these specifications and the accompanying drawings (if any) exceed those of the codes and standards, the drawings and specifications shall supersede.
3. The installation shall conform to provisions of the NFPA requirement with latest amendments.
4. The entire installation including all equipment shall conform to The Occupational and Safety Health Act of 1970, and all EPA regulations.

D. Visit To Site: Bidders are advised to visit the site and carefully examine the existing conditions before submitting bids, as no allowance will be made for lack of knowledge of existing conditions where such conditions may reasonably be determined by observation.

E. Permits

1. Obtain all permits required for the installation of this work and pay all fees in connection therewith. Permits and fees involved in removal of any item from the site shall be included.
2. Provide copies of inspection and testing certificates from all agencies and authorities having jurisdiction.

F. Layout Basis

1. The layout, which must be stamped by an Engineer registered in the State in which the Project is located, is based upon the use of particular items of equipment, identified by manufacturer's make and model number. Dimensions, arrangements, efficiency and service connections required for these particular items have been considered in making the layout. Contractor shall submit any deviations proposed with its bid.
2. The Contractor may use the equipment of any manufacturer listed as approved for substitution provided they have the proper connections, capacities, efficiency and dimensions. Variances from the requirements stated herein shall be sustainable reasons for disapproval of the submitted equipment. All costs arising from variances in substituted items shall be paid for by the Contractor.

3. Equivalent products by other manufacturers must be submitted to the the Owner for prior approval at least ten (10) days prior to bid date.

G. Submittals

1. All submittals shall bear a stamp or notation indicating that the Contractor has reviewed the submittals for compliance with drawings, governing authorities and specifications.
2. All submittals shall bear sufficient notations to clearly indicate the specific make, model number, accessories, capacities, options, and specification paragraph numbers.
3. All submittals shall indicate complete compliance with all performance and specification requirements as herein specified and/or indicated or shall specifically list any exceptions. Exceptions shall be subject to approval by the the Owner.
4. The review (by the the Owner) of equipment does not relieve the Contractor of the responsibility for compliance with the contract documents or authorities as specified.
5. Contractor shall coordinate electrical characteristics of equipment with electrical specifications and the available power characteristics.
6. Materials requiring shop drawing submittals shall not be installed prior to shop drawings being reviewed by the the Owner. The Contractor agrees that failure to conform to the above may result in removal of all installed materials that have been disapproved from the project. Installation of specified equipment will be mandatory. Removal of disapproved equipment shall be at the sole expense of the Contractor.
7. Submit the following for review via shop drawings (to be approved or disapproved):
 - a. Xerxes or approved equal, double wall (do not unload manually). Size and capacity.
 - b. Bury depth.
 - c. Bed and backfill (not over 7'-0" traffic and no traffic).
 - d. Double walls when continuous vacuum pump and monitor are used require a maximum burial depth of three (3) feet from tank top to grade.
 - e. When not subjected to traffic loads, use 24" backfill or 12" minimum backfill plus 4" re-bar reinforced concrete on top.
 - f. When subjected to traffic loads, use 36" backfill or 18" minimum backfill plus 6" of re-bar reinforced concrete.
 - g. If tank is 12'-0" in diameter (actually, 7'-11" is manufactured for large gallonage) then, no traffic shall be provided with 42" minimum cover, or 38" backfill plus 4" re-bar reinforced concrete. With traffic, use 38" backfill plus 6" of asphalt or 6" of re-bar reinforced concrete.
 - h. Monitoring fittings, fiberglass reservoir, vapor sensor 4" tank fittings, tank fill tube insert, venting, stage two vapor recovery system, manway and manway extensions, manway risers, site monitoring wells, barricades, installation check list, hydrostatic tank monitoring.
 - i. Job site safety precautions.
 - j. Reservoir fiberglass sensor.
 - k. Reservoir leak detection.
 - l. Electronic control panels, sensor circuit, transmission contact switch power source circuit, alarm bell, alarm bell silence button, control panel false alarms, etc.
 - m. Piping sump bottom, usually 28 3/8" x 30".
 - n. Flex connectors to piping.
 - o. Unions, nipples, manway cover, FRP fitting, opening for stage II vapor recovery line if required.
 - p. 3" pipe sump fitting.
 - q. When using piping sump sensor equal to Owens Corning fiberglass model PSS, submit system including electrical power supply and signal wiring.
 - r. Control panel equal to Owens Corning fiberglass model SB-0011B (single circuit) or SB-0014B (4 circuit) as applicable.
 - s. Fiberglass pipe and fittings equal to "Ameron" type Dualoy 3000/L pressure rated and with chemically resistant epoxy resin for the service intended. The Dualoy 3000/L shall be a secondary containment system. No other product piping will be acceptable.

H. Guarantee

1. Contractor shall guarantee that if any materials or workmanship covered by these specifications proves defective within one (1) year, such defects shall be corrected by the Contractor at once without charge to the Owner.

1.2 PRODUCTS:

A. Single-Wall Fiberglass Underground Storage Tanks

1. The tank shall comply with the following governing standards:
 - a. Underwriters Laboratories, Inc. (UL) Standard 1316. A UL certification plate shall be attached to each tank.
 - b. National Sanitation Foundation Standard, NSF Standard 61.
 - c. ANSI/AWWA D120-02 Thermosetting Fiberglass-Reinforced Plastic Tanks.
 - d. Military Specification No. MIL-T-52777(A)
2. The Contractor shall provide and install the "fiberglass" underground storage tanks. Tanks shall be as manufactured by Xerxes Corporation, Minneapolis, MN or approved equal as judged by the Owner. Follow manufacturer's instructions for installation and testing.
3. Loading Conditions: Tank shall meet the following design criteria:
 - a. Internal Load: Tank shall be designed to withstand a 5-psig air-pressure test with 5:1 safety factor. When tank is designed for on-site testing, contractor shall individually test tank for leakage prior to installation. Maximum test pressure is 5 psig (3 psig for a 12-foot diameter tank).
 - b. Vacuum Test: Tanks 10-foot diameter and smaller shall be designed to withstand a vacuum test to 11.5 inches of mercury.
 - c. Surface Loads: Tank shall withstand surface H-20 axle loads when properly installed according to tank manufacturer's current Installation Manual and Operating Guidelines.
 - d. External Hydrostatic Pressure: Tank shall be capable of being buried in ground with 7 feet of overburden over the top of the tank, the hole fully flooded and a safety factor of 5:1 against general buckling.
 - e. Tank shall support accessory equipment- such as internal pump platforms, drop/fill tubes, submersible pumps and ladders- when installed according to tank manufacturer's current Installation Manual and Operating Guidelines.
4. Product Storage:
 - a. Tank shall be capable of storing water products with specific gravity up to 1.1.
 - b. Tank shall be vented to atmospheric pressure.
 - c. Tank shall be capable of storing products identified in the manufacturer's current standard limited warranty.
5. Materials:
 - a. Tank shall be manufactured with 100% resin and glass-fiber reinforcement No sand fillers.
 - b. The laminate materials used in the internal coating system of a portable water tank shall conform to the requirements of NSF Standard 61.
 - c. Tank Dimensions: as directed by the Owner.
6. Manways (Required for Potable Water Tanks): Shall be flanged and 22-inch I.D. **OR** 30-inch I.D. (for larger tanks), **as directed**, complete with gasket, bolting hardware and cover. Optional manway extensions shall be FRP.

B. Double-Wall Fiberglass Underground Storage Tanks

1. The Contractor shall provide and install the "fiberglass" underground storage tanks of the specified volume and diameter.
2. The tank shall be of fiberglass. Tank laminates shall be constructed of 100% resin and fiberglass reinforcements without sand fillers. Ribs are to be integrally cast into tank body. Tanks shall bear the listing mark of Underwriters' Laboratories, Inc. Tank shall have an annular space between the primary and secondary shell walls to allow for free flow and containment of all leaked product from primary tank. This space shall be filled at the factory with a brine solution for hydrostatic monitoring. Tanks shall be as manufactured by Xerxes Corporation, Minneapolis, MN or approved equal as judged by the Owner.

3. The tank shall comply with the following governing standards:
 - a. ASTM Standard Document No. 4021-81
 - b. Underwriters' Laboratories, Inc. (UL.) File #MH-9061 (N) for underground storage of flammable liquids. A UL certification plate shall be attached to each tank.
 - c. Military Specification No. MIL-T-52777(A)
 - d. Factory Mutual Systems approval J.I. IG4AO.AF
 - e. National Sanitation Foundation, Standard 14
 - f. National Fire Protection Association (NFPA-30), (NFPA-30A) Flammable and Combustible Liquid Code and (NFPA-31) Standard for Installation of Oil Burning Equipment.
 4. The tank shall be capable of the following loading conditions:
 - a. Internal load: Tank shall withstand 5 psi air pressure test with 5 to 1 safety factor. Contractor shall test prior to installation as this is to test for leakage. Maximum test pressure is 5 psi.
 - b. Vacuum Test: Every tank shall be tested to 11.5 inches (primary tank) and 9.5 inches (secondary tank) mercury vacuum by the tank manufacturer to assure structural integrity.
 - c. Surface Loads: Tank shall withstand surface H-20 axle load when properly installed according to current manufacturer's installation instruction (32,000 lbs.).
 - d. External hydrostatic pressure: Tank shall withstand 7' of overburden with the hole fully flooded with 7:1 safety factor against buckling.
 5. Provide glass fiber-reinforced plastic straps for the tank shown. Provide number and location of straps as specified by the manufacturer. Each strap shall be capable of withstanding the buoyancy load of 25,000 lbs. for 8' tank diameter. Straps shall be standard as supplied by the tank manufacturer. A concrete pad or concrete deadman must be used with anchor straps as recommended by tank manufacturer.
 6. The Contractor shall provide fiberglass piping sump with fittings as indicated. The piping sump shall be manufactured by Xerxes Corporation or approved equal and supplied with tanks.
 - a. The piping sump shall be installed so that it is suitable for monitoring the double-wall piping system and containment of its product. Piping sump shall be located on tanks 22" minimum manway.
 7. All tank fittings shall be standard (proofed tight) as supplied by the tank manufacturer. The tank shall have an opening for one each of the following:
 - a. Fill/Manual Gauging
 - b. Vent/Overfill/Stage One Vapor Recovery
 - c. Pump (pressure system) or supply and return (suction system)
 - d. In tank gauging automatic inventory control
 - e. Others as shown or required by the operating agency
 8. The tank shall have a factory filled brine interstitial and reservoir for continuous monitoring of both inner and outer walls.
 9. Tank to be installed per manufacturer installation instructions which will be inspected as it progresses.
- C. Spill Protection
1. Universal model 70CD, or approved equal, spill containment shall be used as containment basin for spills during filling. A manual valve, if so required, shall be used to return any spilled product back to tank.
- D. Overfill Prevention
1. Universal model 37, or approved equal, float valve is to be used for overfill prevention. The automatic shut off device must stop the flow of product being delivered when tank is 90% full. Access must be provided.
- E. Stage One Vapor Recovery
1. Stage one vapor recovery is incorporated into the access assembly of the overfill prevention access way. See drawing for details. (Less than 10,000 gals per month through flow)

- F. Stage Two Vapor Recover
 - 1. Piping for stage two vapor recovery will be installed for future use. Required for gasoline motor fuel only. (More than 10,000 gales per month through flow)
- G. Tank Trim
 - 1. Surface manholes shall have all cast iron rim and minimum 10" galvanized steel skirt. Tank trim shall have Universal Valve.
- H. Submersible Turbine Pump Specifications
 - 1. General Pump Specifications: The pump shall be designed to pump gasoline, diesel, kerosene and jet fuel. The entire pumping assembly shall have UL listing and shall meet all requirements of UL79. The pump discharge head and manifold assembly shall be manufactured from ASTM A 48 Class 30 grey iron. The pump shall be available in 1/3, 3/4, and 1-1/2 hp sizes and shall be manufactured to the proper length as determined by the tank diameter, type of tank, and bury depth. The pump motor shall have a thermal over current protector with automatic reset. The pump motor assembly shall be clearly marked with pertinent information including Model, Horsepower, Voltage, Phase, and Manufacturer. The pump motor shall be a permanent split phase capacitor type, and shall incorporate a 15 mfd capacitor. The pumping unit shall not incorporate any flexible diaphragms and all sealing shall be accomplished with "o" ring or UL recognized fiber gaskets. The pump shall have a removable intake screen with openings no greater than 3/32 inch. The pump shall be manufactured by FE Petro, Inc., McFarland, WI. or approved equal as judged by the the Owner.
 - 2. Installation and Maintenance Specifications: The pump shall have a two-wire field connection and an easy access ground wire terminal, and shall incorporate a wire seal plug which will accommodate three wires. The pump shall incorporate a port for line pressure testing that shall be sealed with a 1/4 NPT pipe plug. The pump unit shall have a fully extractable head in order to permit removal of the pump motor assembly without disturbing the discharge piping or the electrical wiring. The product in the pipelines shall be held in place by a line check valve that shall have a minimum sealing of 170 lbs when the pump is not running. The line check valve shall be independent of the removable head and shall be easily accessible. The removal of the extractable portion of the pump shall not disturb product in the pipelines downstream of the check valve. During the removal of the extractable portion of the pump, product contained in the discharge manifold of the pump shall drain automatically into the storage tank. The pump motor shall be interchangeable by horsepower with different manufacturers' product.
 - 3. Operation Specifications: The pump shall have an air/vapor elimination system that returns air or vapors to the underground storage tank through a tube discharging near the top of the pump motor assembly. The pump unit shall contain a built-in expansion relief valve that relieves pressure above pumping pressure but below 50 psi. The pump motor shall utilize the product being pumped for lubrication of the motor bearings and for cooling the stator, and this fluid shall discharge into the underground storage tank at the top of the motor. The pump shall have siphon capability built into the pump as standard.
- I. Piping System
 - 1. All piping fittings and adhesives shall be UL listed made of fiberglass double wall. Pipe shall be in compliance with ASTM D 2996 and classified by designation code RTRP-11AF-3111. Pipe shall be filament wind of continuous glass filament. Pipe must have a minimum bend radius of 50 feet on 2" primary (80 feet on 3" secondary) to allow settling of tank. Pipe shall have maximum tensile loads of 1160 lbs, compressive loads 2210 lbs at 75 degrees Fahrenheit on 2" primary. 3" pipe shall have tensile load of 2020 lbs at 75 degrees and compressive loads of 3850 lbs. Pipe to be factory proof tested at 1000 psig-2", 700 psig-3". Pipe shall be Smith Fiberglass Red thread II, or approved equal as judged by the Owner.
 - 2. Vent piping shall not have secondary containment. Vent shall not be sloped less than 1/4" per foot downward to tank.
 - 3. Product piping shall have secondary containment. Product piping shall not be sloped less than 1/8" per foot downward toward tank.
 - 4. All piping must slope back toward tank.

5. All piping must be installed as per manufacturer installation instructions. the Owner shall monitor each installation daily.

J. Leak Detection

1. Tank shall have a Pollulert FD241RRA, or approved equal, float probe mounted on the brine filled hydrostatic reservoir. The system shall monitor both the inner and outer walls of the tank.
 - a. Alarm Conditions:
 - 1) Hydrocarbons in hydrostatic reservoir
 - 2) A loss of fluid in reservoir
2. Piping shall have a Pollulert FD241RRA, or approved equal, float probe mounted in the piping sump. System shall monitor the piping sump compartment that has to be designed to catch any leaked product from the primary piping system. This probe shall distinguish the difference between water and hydrocarbons and alarm on any one or both conditions.
3. Remote monitoring piping sumps shall be installed only if piping can not be sloped toward tank. The Contractor shall use as many remote monitoring piping sumps as needed to assure that all sections of piping are monitored. All monitoring sumps shall have a Pollulert FD241RRA or approved equal probe for leak detection.
4. Control panel shall have probe status for wet, dry, or hydrocarbon. Alarm conditions are to be selectable. Control panel must have installed relay or provision for installing relays for remote alarms. Control panel shall have both visual and audible alarm. System shall have a two year warranty from date of manufacture. Ground water probes shall be adjustable 1/8" to 2" for product detection. Probes shall be wired by a single cable run. Systems must be UL listed for Class 1, Division 1, Group D locations and meet all existing EPA regulations. Leak detection shall be Pollulert systems or approved equal.
5. Submersible pump shall have a mechanical in-line leak detector with a free floating check valve. Leak detector shall be vaporless LD2000 or approved equal.

K. In Tank Gauging System

1. Gauging system shall provide inventory management designed to continuously monitor underground storage tanks. System must provide information on inventory, delivery of fuel, and product through-put. System must measure fuel levels, water level and fuel temperature. This is to ensure proper compensated level readings. System shall have five temperature sensors, two floats, one for product level, one for water interface. System shall have a 48 character LCD display and internal thermal printer. System shall utilize a magnetostrictive probe and have visual, audible alarm with automatic printout. The system shall be designed to have 16 input on/off devices, RS232 port full duplex with adjustable baud rate. Tank gauging system shall be Pollulert system or approved equal.

L. Test For Pipe

1. Test of the piping system shall be made per manufacturer's recommendations.
2. Furnish the Owner with a certificate stating that all piping has been tested as specified and has been shown to be tight.
3. The piping systems may be tested in sections if necessary, but a final test may be required of the entire piping system at the completion of the system. The final test shall be made while pipe is exposed to view where possible.
4. Both primary and secondary pipe must be tested.

M. Test For Tank

1. Pre-installation: All Xerxes or approved equal tanks shall be tested prior to shipment, but it is required that all tanks be tested by the Contractor prior to installation. After installation and before final backfilling to grade, the tank must be retested to assure that no damage occurred during installation.
2. Hose/Valve Assembly: In order to test the tank, the hose/valve assembly must be connected from the reservoir to a service fitting. The hose/valve assembly will already be connected from the reservoir to a service fitting when the tank is shipped. If the hose/valve assembly is not connected

- when the tank is delivered, contact the Customer Service Representative at the Xerxes or other plant nearest you, before attempting to test the tank.
3. Primary (Internal) Tank Test: Prior to installation, check to see that all service and monitor fittings are plugged and tightened, except the service fitting with a temporary plastic plug. Close the valve on the hose/valve assembly. Remove the temporary plastic plug and connect the pressure source to the service fitting. Pressure test the primary (internal) tank to 5 psig for 60 minutes.
 4. Secondary (External) Tank Test:
 - a. CAUTION: Never pressurize the secondary tank or (annular space) without connecting it to the primary tank. The secondary tank and primary tank will be properly connected if the hose/valve assembly is in place as shipped. Failure to have the secondary tank and primary tank properly connected could potentially result in tank failure and personal injury, and will void all warranties.
 - b. While the primary tank is still under pressure, open the valve on the hose/valve assembly until the pressure stabilizes. Once the pressure has stabilized, either add or subtract air pressure to stabilize the pressure at 5 psig. Observe the tank for any liquid on the exterior surface and check the gauge at the pressure source for any drop in pressure.
 - c. After completing the test, relieve the pressure at the source.
- N. Product Dispenser
1. A fiberglass containment box shall be installed with each product dispenser. Containment box shall be as manufactured by Petro Fiberglass or approved equal. Double wall pipe shall terminate inside containment box. A flex connector as manufactured by Dana Everflex or approved equal shall be used to connect product pipe to the shear valve within the containment box. The shear valve shall be air tested at the factory and shall not lose its seal when its top is removed for service. Shear valve shall be Universal model 521 or approved equal. Each product dispensing hose shall be equipped with a re-connectable breakaway featuring a pressure balancing chamber to prevent nuisance breaks and shall disconnect at 200 lbs. A hose coupling shall separate the breakaway and hose swivel. The nozzle shall have a means of automatically stopping flow if the nozzle is not at the proper dispensing angle. Nozzle shall be of die-cast construction UL listed and have a flow equalizer to maintain 10 GPM flow. Breakaway, hose coupling, hose swivel, and nozzle shall be as manufactured by Husky or approved equal. Dispenser shall be compatible with vapor recovery systems.

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SECTION 28 46 00 00 - OIL/WATER SEPARATOR

1.1 GENERAL

A. Description Of Work

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

B. Scope

1. The separator shall be designed for gravity separation of sand, grit, settleable solids, or semisolids, and free oils (hydrocarbons and other petroleum products) from wastewater. Separator shall be installed belowground with top access at or above grade level. The source of the influent to the separator shall be gravity flow from storm water runoff, hydrocarbon spills, and/or cleaning/maintenance operations.

C. Performance

1. Influent Characteristics

- a. Provide separator designed for intermittent and variable flows of water, oil, or any combination of non-emulsified oil-water mixtures. Minimum separator retention time shall be 10 minutes. Operating temperatures of the influent oil in water mixture shall range from 40 degrees F. to 80 degrees F. The specific gravity of the oils at operating temperatures shall range from 0.71 to 0.92. The specific gravity of the fresh water at operating temperatures shall range from 1.00 to 1.03.

2. Effluent Characteristics

- a. The free oil and grease concentration in the effluent from the separator shall not exceed 10 mg/l (10 PPM) to satisfy requirements of the NPDES stormwater discharge permit. To achieve this goal, it will be necessary to remove all free oil droplets equal to and greater than 20 microns.

D. Design Criteria

1. The separator shall be listed to Underwriters' Laboratories UL-SU2215. Construction and performance of the oil/water separators shall be in accordance with UL-SU2215. Provide certification documentation detailing criteria under which the system was tested. UL-SU2215 label shall be prominently displayed on manway covers.
2. Separator shall be designed in accordance with Stokes Law and the American Petroleum Institute Publication 421, "Monographs on Refinery Environmental Control - Management of Water Discharges; Design and Operation of Oil/Water Separators." Effective surface area calculations, signed and stamped by a Registered Professional Engineer shall be submitted to document specified effluent quality based on complete removal of the specified oil globule at design flow. A separator with lower effective surface area than required is not permissible.
3. Separator capacities, dimensions, construction, and thickness shall be in strict accordance with Underwriters' Laboratories, Subject UL-58 Standard for Safety, Steel Underground Tanks for Flammable and Combustible Liquids, September 30, 1997, Double Wall construction with 360 degree Steel Secondary Containment. The inner steel tank shall be completely contained within the outer steel tank, enclosing 100% of the tank volume. The tank shall have a double steel shell with a space between the layers. The space between the inner and outer steel walls shall be monitored with an approved electronic leak detection device through a pipe that extends vertically to the top of the tank from a small sump at the bottom. Tank construction using thin walled primary tank with external fiberglass jacket shall not be permissible.
4. Separator Corrosion Control System shall be in strict accordance with Underwriters' Laboratories Inc. Subject UL-1746 Standard for External Corrosion Protection Systems for Steel Underground Storage Tanks and the HighGuard® External Corrosion Protection Specifications.

5. Oil/water separator shall comply with National Fire Protection Association NFPA 30 Flammable and Combustible Liquids Code, 2003 Edition.
6. Separator vessel volume shall allow for a hydraulic retention time of ten (10) minutes to ensure laminar flow conditions which result in hydraulic uniformity and high effluent quality. Volume reduction will adversely affect separator performance by increasing horizontal velocity and turbulence, therefore a separator of smaller volume is not permissible.
7. Separator shall be the standard patented product of a steel tank manufacturer regularly engaged in the production of such equipment. Manufacturer shall have at least 20 years experience in manufacturing similar units for identical applications. No subcontracting of tank fabrication shall be permitted.
8. Separator shall be fabricated, inspected, and tested for leakage before shipment from the factory by manufacturer as a completely assembled vessel ready for installation.
9. Separator shall be cylindrical, horizontal, atmospheric-type steel vessel intended for the separation and storage of flammable and combustible liquids. The separator shall have the structural strength to withstand static and dynamic hydraulic loading while empty and during operating conditions. The Oil/Water Separator's dimensions and thickness shall be in strict compliance with Roark's Formulas for Stress and Strain as presented in UL 58, September 30, 1997. Calculations, signed and stamped by a Registered Professional Engineer shall be submitted to document structural strength under specified overbearing or external pressure. A separator with a reduced shell thickness is not permissible.
10. Separator shall have an oil storage capacity equal to about 43% of the total vessel volume and an emergency oil spill capacity equal to 80% of the total vessel volume.
11. To prevent extensive shutdown and maintenance, the separator design must allow solids to fall unhindered by turbulence, and oil droplets to rise without risk of re-emulsifying due to collisions with interfering solids. The use of plastic perforated tubes, spherical balls, or irregular shaped media will increase the facility's maintenance costs and shall not be permitted.
12. Separator shall consist of inlet and outlet connections, integral sand interceptor compartment, non-clogging flow distributor and energy dissipater device, stationary under flow baffle, presettling chamber for solids, sludge baffle, oil coalescing chamber with removable parallel flat/corrugated plate coalescer, with removable plates, and sectionalized removable polypropylene impingement coalescers to optimize separation of free oil from water, effluent downcomer positioned to prevent discharge of free oil that has been separated from the water, access ways for coalescers and each chamber, fittings for vent, oil pump-out, sampling, gauging, leak detection, and lifting lugs.

E. Submittals:

1. Shop Drawings: shop drawings for oil water separators shall show principal dimensions and location of all fittings.
2. Instructions: provide three complete sets of installation, operation, and maintenance instructions with separator.
3. Quality Control: Quality control, inspection procedures, and reports shall be considered part of the submittal package.

F. Warranty

1. The manufacturer shall warrant its products to be free from defects in material and workmanship for a period of one year from the date of shipment. The warranty shall be limited to repair or replacement of the defective part(s).
2. The manufacturer's warranty shall be standard limited warranty in effect at time of purchase.

1.2 PRODUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Highland Tank, One Highland Road, Box 338, Stoystown, PA 15563, Phone 814-893-5701, FAX 893-6126, E-mail ows.info@highlandtank.com, Website <http://www.highlandtank.com>

B. Product

1. Provide and install Highland Tank Model HTC Series "G" UL-SU2215 approved Belowground Double Wall Parallel Flat/Corrugated Plate Gravity Displacement Oil/Water Separator with Integral Sand Interceptor Compartment. Separator shall be furnished with oil level alarm and leak detection systems. Oil/Water Separator shall be of capacity to comply with Spill Prevention Control and Countermeasures (SPCC) plan requirements at the facility. The sizing of this oil/water separator is consistent with industry protocols for complying with the minimum federal spill and discharge regulations therefore a separator of smaller volume is not permissible.
2. Separator shall be furnished with a Corella™ inclined parallel flat/corrugated plate coalescer to simultaneously separate free oil droplets and settleable or suspended solids particles from water without clogging of the coalescer.

C. Description

1. Separator shall be standard prefabricated inclined parallel flat/corrugated plate, gravity displacement type unit.
2. Separator shall be cylindrical with capacities, dimensions, construction, and thickness in strict accordance with Underwriters' Laboratories Subject 58, Double Wall construction using flat-flanged heads. Separator shall comply with National Fire Protection Association NFPA 30 Flammable and Combustible Liquids Code, 2003 Edition.
3. The separator shall be a pre-packaged, pre-engineered, ready to install unit consisting of:
 - a. An influent connection, flanged. An internal influent nozzle at the inlet end of the separator. Nozzle discharge to be located at the furthest diagonal point from the effluent discharge opening.
 - b. An integral sand interceptor compartment containing one (1) manhole, UL approved, complete with extension, cover, gasket, and bolts. A heavy-duty bulkhead shall retain sand, grit, settleable solids or semisolids and prevent them from entering the separation chamber. Bulkhead shall have a transfer pipe.
 - c. A velocity head diffusion baffle at the inlet to:
 - 1) reduce horizontal velocity and flow turbulence.
 - 2) distribute the flow equally over the separator's cross sectional area.
 - 3) direct the flow in a serpentine path in order to enhance hydraulic characteristics and fully utilize all separator volume.
 - 4) completely isolate all inlet turbulence from the separation chamber.
 - d. A sediment chamber to disperse flow and collect oily solids and sediments.
 - e. A sludge baffle to retain settleable solids and sediment and prevent them from entering the separation chamber.
 - f. An Oil/Water Separation Chamber containing a removable Corella™ inclined parallel flat/corrugated plate coalescer. The coalescer shall have individual removable plates, sloped towards the sediment chamber. Each coalescing plate shall be flat on the top and corrugated on the bottom. The flat top plate shall resist clogging and clotting with solids. The corrugations of each of the plate bottoms shall be shaped and positioned to enhance collisions between the rising oil droplets and coalesce between them thereby improving separator efficiency. The coalescer shall:
 - 1) effect separation of oil and solids from all strata of the wastewater stream.
 - 2) shorten the vertical distance that an oil globule or solid particle has to rise or sink, respectively, for effective removal. Minimum plate gap to be 3/4".
 - 3) enhance coalescence and agglomeration by causing the smaller globules and particles (those possessing smaller rising/settling rates) to coalesce and collect on the plates thereby forming larger globules and particles that separate rapidly in water.
 - 4) direct the flow paths of the separated oil to the surface of the separator and separated solids to the bottom of the separator.
 - 5) allow solids to fall unhindered by turbulence, and oil droplets to rise without risk of re-emulsifying due to collisions with interfering solids.
 - g. The Oil/Water Separation Chamber shall also contain a sectionalized removable "Petro-Screen"™ polypropylene impingement coalescer designed to intercept oil globules of less

than 20 microns in diameter. Heavy, one-piece impingement coalescers are not permissible.

- h. An internal effluent downcomer at the outlet end of the separator, to allow for discharge from the bottom of the separation chamber only.
- i. An effluent connection, flanged.
- j. Fittings for vent, interface/level sensor, leak detection, waste oil pump-out, sampling, and gauge.
- k. Two (2) manholes, UL approved, complete with extension, cover, gasket, and bolts. One manway shall be placed between the inlet and the parallel flat/corrugated plate coalescer to facilitate access into sediment chamber for solids removal. One manway shall be placed between the parallel flat/corrugated plate coalescer and outlet to facilitate access into the oil water separation chamber for oil removal.
- l. Lifting lugs at balancing points for handling and installation.
- m. Identification plates: Plates shall be affixed in prominent location and be durable and legible throughout equipment life.
- n. HighGuard® Corrosion Protection System consisting of:
 - 1) Isolation Spool Pieces
 - 2) Dielectric Isolation Gaskets and Bushings
 - 3) External surfaces commercial grit blast, coated 75 mils DFT Self-Reinforcing Polyurethane.
- o. Internal surfaces commercial grit blast and coated with 10 mils DFT heavy duty Polyurethane.

D. Accessories

- 1. Separator shall be supplied with an audible and visual alarm system that indicates hi oil level (visual only) and hi hi oil level (audible and visual) of oil storage in the oil/water separator and an audible and visual leak detection alarm system that indicates hydrocarbon and/or water in the interstice. A silence control shall be provided for the audible alarms. Level sensor(s) shall be intrinsically safe. Level sensor floats shall be made of stainless steel. The control panel shall contain both level sensor and detection control. The control panel shall be NEMA 4. Power to the control panel shall be as directed by the Owner.
- 2. Separator shall be supplied with Polyester Hold-down straps.
- 3. Separator shall be supplied with prefabricated Concrete Deadman Anchors.
- 4. Separator shall be supplied with cylindrical and/or rectangular steel Grade Level Manways designed to AASHTO H20 requirements.

1.3 EXECUTION

A. Installation

- 1. Installation shall be in strict compliance with manufacturer's instructions and shall comply with all applicable local, state, and federal requirements.

END OF SECTION 28 46 00 00

SECTION 28 46 21 17 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for digital, addressable fire alarm system. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Fire-alarm control unit.
 - b. Manual fire-alarm boxes.
 - c. System smoke detectors.
 - d. Nonsystem smoke detectors.
 - e. Heat detectors.
 - f. Notification appliances.
 - g. Firefighters' two-way telephone communication service.
 - h. Magnetic door holders.
 - i. Remote annunciator.
 - j. Addressable interface device.
 - k. Digital alarm communicator transmitter.
 - l. Radio alarm transmitter.
 - m. System printer.

C. Definitions

1. LED: Light-emitting diode.
2. NICET: National Institute for Certification in Engineering Technologies.

D. System Description

1. Noncoded, UL-certified **OR** FMG-placarded, **as directed**, addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.
2. Noncoded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.

E. Performance Requirements

1. Seismic Performance: Fire-alarm control unit and raceways 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 and the unit will be fully operational after the seismic event," **as directed**.

F. Submittals

1. General Submittal Requirements:
 - a. Submittals shall be approved by authorities having jurisdiction prior to submitting them to the Owner.
 - b. Shop Drawings shall be prepared by persons with the following qualifications:
 - 1) Trained and certified by manufacturer in fire-alarm system design.
 - 2) NICET-certified fire-alarm technician, Level III **OR** Level IV, **as directed**, minimum.
 - 3) Licensed or certified by authorities having jurisdiction.
2. Product Data: For each type of product indicated.
3. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

- a. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
- b. Include voltage drop calculations for notification appliance circuits.
- c. Include battery-size calculations.
- d. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
- e. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
- f. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
- g. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
4. Delegated-Design Submittal: For smoke and heat detectors 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. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
 - b. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.
5. Qualification Data: For qualified Installer.
6. Seismic Qualification Certificates: For fire-alarm control unit, 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.
7. Field quality-control reports.
8. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. Deliver copies to authorities having jurisdiction and include the following:
 - a. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - b. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
 - c. Record copy of site-specific software.
 - d. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - 1) Frequency of testing of installed components.
 - 2) Frequency of inspection of installed components.
 - 3) Requirements and recommendations related to results of maintenance.
 - 4) Manufacturer's user training manuals.
 - e. Manufacturer's required maintenance related to system warranty requirements.
 - f. Abbreviated operating instructions for mounting at fire-alarm control unit.
 - g. Copy of NFPA 25.
9. Software and Firmware Operational Documentation:
 - a. Software operating and upgrade manuals.
 - b. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - c. Device address list.
 - d. Printout of software application and graphic screens.

G. Quality Assurance

1. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
2. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II **OR** Level III **OR** Level IV, **as directed**, technician.
3. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL.
6. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.
7. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FMG-approved alarm company.
8. NFPA Certification: Obtain certification according to NFPA 72 by agency having jurisdiction.

H. Project Conditions

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

I. Sequencing And Scheduling

1. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.
2. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

J. Software Service Agreement

1. Comply with UL 864.
2. Technical Support: Beginning with Final Completion, provide software support for two years.
3. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Final Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - a. Provide 30 days' notice to the Owner to allow scheduling and access to system and to allow the Owner to upgrade computer equipment if necessary.

1.2 PRODUCTS

A. Systems Operational Description

1. Fire-alarm signal initiation shall be by one or more of the following devices and systems, **as directed**:
 - a. Manual stations.
 - b. Heat detectors.
 - c. Flame detectors.
 - d. Smoke detectors.
 - e. Duct smoke detectors.
 - f. Verified automatic alarm operation of smoke detectors.
 - g. Automatic sprinkler system water flow.
 - h. Heat detectors in elevator shaft and pit.

- i. Fire-extinguishing system operation.
- j. Fire standpipe system.
- 2. Fire-alarm signal shall initiate the following actions:
 - a. Continuously operate alarm notification appliances.
 - b. Identify alarm at fire-alarm control unit and remote annunciators, **as directed**.
 - c. Transmit an alarm signal to the remote alarm receiving station.
 - d. Unlock electric door locks in designated egress paths.
 - e. Release fire and smoke doors held open by magnetic door holders.
 - f. Activate voice/alarm communication system.
 - g. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 - h. Activate smoke-control system (smoke management) at firefighter smoke-control system panel.
 - i. Activate stairwell and elevator-shaft pressurization systems.
 - j. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 - k. Recall elevators to primary or alternate recall floors.
 - l. Activate emergency lighting control.
 - m. Activate emergency shutoffs for gas and fuel supplies.
 - n. Record events in the system memory.
 - o. Record events by the system printer.
- 3. Supervisory signal initiation shall be by one or more of the following devices and actions:
 - a. Valve supervisory switch.
 - b. Low-air-pressure switch of a dry-pipe sprinkler system.
 - c. Elevator shunt-trip supervision.
- 4. System trouble signal initiation shall be by one or more of the following devices and actions:
 - a. Open circuits, shorts, and grounds in designated circuits.
 - b. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 - c. Loss of primary power at fire-alarm control unit.
 - d. Ground or a single break in fire-alarm control unit internal circuits.
 - e. Abnormal ac voltage at fire-alarm control unit.
 - f. Break in standby battery circuitry.
 - g. Failure of battery charging.
 - h. Abnormal position of any switch at fire-alarm control unit or annunciator.
 - i. Fire-pump power failure, including a dead-phase or phase-reversal condition.
 - j. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.
- 5. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators, **as directed**. Record the event on system printer.

B. Fire-Alarm Control Unit

- 1. General Requirements for Fire-Alarm Control Unit:
 - a. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
 - 1) System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
 - 2) Include a real-time clock for time annotation of events on the event recorder and printer.
 - b. Addressable initiation devices that communicate device identity and status.
 - 1) Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit, **as directed**.
 - 2) Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
 - c. Addressable control circuits for operation of mechanical equipment.

2. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 - a. Annunciator and Display: Liquid-crystal type, 1 **OR** 2 **OR** 3, **as directed**, line(s) of 40 **OR** 80, **as directed**, characters, minimum.
 - b. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters, **as directed**.
3. Circuits:
 - a. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.
 - 1) Initiating Device Circuits: Style D **OR** Style E, **as directed**.
 - 2) Notification Appliance Circuits: Style Z.
 - 3) Signaling Line Circuits: Style 2 **OR** Style 5 **OR** Style 6 **OR** Style 7, **as directed**.
 - 4) Install no more than 50 addressable devices on each signaling line circuit.
 - b. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.
 - 1) Initiating Device Circuits: Style A **OR** Style B **OR** Style C, **as directed**.
 - 2) Notification Appliance Circuits: Style W **OR** Style X **OR** Style Y, **as directed**.
 - 3) Signaling Line Circuits: Style 0.5 **OR** Style 1 **OR** Style 3 **OR** Style 3.5 **OR** Style 4 **OR** Style 4.5, **as directed**.
 - 4) Install no more than 50 addressable devices on each signaling line circuit.
 - c. Serial Interfaces: Two RS-232 ports for printers.
4. Stairwell Pressurization: Provide an output signal using an addressable relay to start the stairwell pressurization system. Signal shall remain on until alarm conditions are cleared and fire-alarm system is reset. Signal shall not stop in response to alarm acknowledge or signal silence commands.
 - a. Pressurization starts when any alarm is received at fire-alarm control unit.
 - b. Alarm signals from smoke detectors at pressurization air supplies have a higher priority than other alarm signals that start the system.
5. Smoke-Alarm Verification:
 - a. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
 - b. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
 - c. Record events by the system printer.
 - d. Sound general alarm if the alarm is verified.
 - e. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
6. Notification Appliance Circuit: Operation shall sound in a <Insert pattern>.
7. Elevator Recall:
 - a. Smoke detectors at the following locations shall initiate automatic elevator recall. Alarm-initiating devices, except those listed, shall not start elevator recall, **as directed**.
 - 1) Elevator lobby detectors except the lobby detector on the designated floor.
 - 2) Smoke detector in elevator machine room.
 - 3) Smoke detectors in elevator hoistway.
 - b. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
 - c. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
 - 1) Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.
8. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be **OR** not be, **as directed**, connected to fire-alarm system.
9. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-

adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

10. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
11. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided in a separate cabinet located in the fire command center **OR** as a special module that is part of fire-alarm control unit, **as directed**.
 - a. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711 and be listed by an NRTL.
 - 1) Allow the application of and evacuation signal to indicated number of zones and, at same time, allow voice paging to the other zones selectively or in any combination.
 - 2) Programmable tone and message sequence selection.
 - 3) Standard digitally recorded messages for "Evacuation" and "All Clear."
 - 4) Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control unit.
 - b. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
 - c. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
12. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.
13. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals **OR** supervisory and digital alarm communicator transmitters **OR** digital alarm radio transmitters, **as directed**, shall be powered by 24-V dc source.
 - a. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
14. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 - a. Batteries: Sealed lead calcium **OR** Sealed, valve-regulated, recombinant lead acid **OR** Vented, wet-cell pocket, plate nickel cadmium, **as directed**.
15. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

C. Manual Fire-Alarm Boxes

1. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 - a. Single-action mechanism, breaking-glass or plastic-rod **OR** pull-lever, **as directed**, type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 - b. Double-action mechanism requiring two actions to initiate an alarm, breaking-glass or plastic-rod **OR** pull-lever, **as directed**, type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.

- c. Station Reset: Key- or wrench-operated switch.
 - d. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
 - e. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.
- D. System Smoke Detectors
- 1. General Requirements for System Smoke Detectors:
 - a. Comply with UL 268; operating at 24-V dc, nominal.
 - b. Detectors shall be four **OR** two, **as directed**, -wire type.
 - c. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 - d. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - e. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - f. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status, **as directed**.
 - g. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - 1) Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for **15 or 20 deg F (8 or 11 deg C)** per minute.
 - 2) Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at **135 or 155 deg F (57 or 68 deg C)**.
 - 3) Provide multiple levels of detection sensitivity for each sensor.
 - 2. Photoelectric Smoke Detectors:
 - a. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - b. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - 1) Primary status.
 - 2) Device type.
 - 3) Present average value.
 - 4) Present sensitivity selected.
 - 5) Sensor range (normal, dirty, etc.).
 - 3. Ionization Smoke Detector:
 - a. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - b. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - 1) Primary status.
 - 2) Device type.
 - 3) Present average value.
 - 4) Present sensitivity selected.
 - 5) Sensor range (normal, dirty, etc.).
 - 4. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
 - a. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - b. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - 1) Primary status.
 - 2) Device type.
 - 3) Present average value.

- 4) Present sensitivity selected.
- 5) Sensor range (normal, dirty, etc.).
- c. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
- d. Each sensor shall have multiple levels of detection sensitivity.
- e. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
- f. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

E. Nonsystem Smoke Detectors

1. Single-Station Smoke Detectors:

- a. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device, **as directed**.
- b. Auxiliary Relays: One Form C rated at 0.5 A **OR** Form A and one Form C, both rated at 0.5 A, **as directed**.
- c. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet (3 m) according to UL 464.
- d. Visible Notification Appliance: 177-cd strobe.
- e. Heat sensor, 135 deg F (57 deg C) combination rate-of-rise, **as directed**, and fixed temperature.
- f. Test Switch: Push to test; simulates smoke at rated obscuration.
- g. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
- h. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
- i. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
- j. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status, **as directed**.

2. Single-Station Duct Smoke Detectors:

- a. Comply with UL 268A; operating at 120-V ac.
- b. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - 1) Detector Sensitivity: Smoke obscuration between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) when tested according to UL 268A.
- c. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to air duct. Provide terminals in the fixed base for connection to building wiring.
 - 1) Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
- d. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
- e. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

F. Heat Detectors

- 1. General Requirements for Heat Detectors: Comply with UL 521.
- 2. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
 - a. Mounting: Adapter plate for outlet box mounting **OR** Twist-lock base interchangeable with smoke-detector bases, **as directed**.
 - b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

3. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of **190 deg F (88 deg C)**.
 - a. Mounting: Adapter plate for outlet box mounting **OR** Twist-lock base interchangeable with smoke-detector bases, **as directed**.
 - b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 4. Continuous Linear Heat-Detector System:
 - a. Detector Cable: Rated detection temperature **155 deg F (68 deg C)**. NRTL listed for "regular" service and a standard environment. Cable includes two steel actuator wires twisted together with spring pressure, wrapped with protective tape, and finished with PVC outer sheath. Each actuator wire is insulated with heat-sensitive material that reacts with heat to allow the cable twist pressure to short-circuit wires at the location of elevated temperature.
 - b. Control Unit: Two-zone or multizone unit as indicated. Provide same system power supply, supervision, and alarm features as specified for fire-alarm control unit.
 - c. Signals to Fire-Alarm Control Unit: Any type of local system trouble shall be reported to fire-alarm control unit as a composite "trouble" signal. Alarms on each detection zone shall be individually reported to central fire-alarm control unit as separately identified zones.
 - d. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- G. Notification Appliances
1. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.
 2. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
 - a. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
 3. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.
 4. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.
 5. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured **10 feet (3 m)** from the horn, using the coded signal prescribed in UL 464 test protocol.
 6. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum **1-inch- (25-mm-)** high letters on the lens.
 - a. Rated Light Output:
 - 1) **15 OR 30 OR 75 OR 110 OR 177, as directed, cd.**
OR
15/30/75/110 cd, selectable in the field.
 - b. Mounting: Wall mounted unless otherwise indicated.
 - c. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 - d. Flashing shall be in a temporal pattern, synchronized with other units.
 - e. Strobe Leads: Factory connected to screw terminals.
 - f. Mounting Faceplate: Factory finished, red **OR** white, **as directed**.
 7. Voice/Tone Notification Appliances:
 - a. Appliances shall comply with UL 1480 and shall be listed and labeled by an NRTL.
 - b. High-Range Units: Rated 2 to 15 W.
 - c. Low-Range Units: Rated 1 to 2 W.
 - d. Mounting: Flush **OR** Semirecessed **OR** Surface mounted and bidirectional, **as directed**.

- e. Matching Transformers: Tap range matched to acoustical environment of speaker location.
- H. Firefighters' Two-Way Telephone Communication Service
- 1. Dedicated, two-way, supervised, telephone voice communication links between fire-alarm control unit, the fire command center, **as directed**, and remote firefighters' telephone stations. Supervised telephone lines shall be connected to talk circuits by controls in a control module. Provide the following:
 - a. Common-talk type for firefighter use only.
 - b. Selective-talk type for use by firefighters and fire wardens.
 - c. Controls to disconnect phones from talk circuits if too many phones are in use simultaneously.
 - d. Audible Pulse and Tone Generator, and High-Intensity Lamp: When a remote telephone is activated, it causes audible signal to sound and high-intensity lamp to flash.
 - e. Selector panel controls shall provide for simultaneous operation of up to six telephones in selected zones. Indicate ground faults and open or shorted telephone lines on the panel front by individual LEDs.
 - f. Display: Graphic **OR** Liquid-crystal digital, **as directed**, to indicate location of caller.
 - g. Remote Telephone Cabinet: Flush- or surface-mounted cabinet as indicated, factory-standard red finish, with handset.
 - 1) Install one-piece handset to cabinet with vandal-resistant armored cord. Silk-screened or engraved label on cabinet door, designating "Fire Warden Phone" **OR** "Fire Emergency Phone", **as directed**.
 - 2) With "break-glass" type door access lock.
 - h. Remote Telephone Jack Stations: Single-gang, stainless-steel-plate mounted plug, engraved "Fire Warden Phone" **OR** "Fire Emergency Phone", **as directed**.
 - i. Handsets: **<Insert number>** push-to-talk-type sets with noise-canceling microphone, **as directed**, stored in a cabinet adjacent to fire-alarm control unit **OR** in the fire command center, **as directed**.
- I. Magnetic Door Holders
- 1. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
 - a. Electromagnet: Requires no more than 3 W to develop **25-lbf (111-N)** holding force.
 - b. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 - c. Rating: 24-V ac or dc.
 - d. Rating: 120-V ac.
 - 2. Material and Finish: Match door hardware.
- J. Remote Annunciator
- 1. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
 - a. Mounting: Flush **OR** Surface, **as directed**, cabinet, NEMA 250, Type 1.
 - 2. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.
- K. Addressable Interface Device
- 1. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.
 - 2. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall **OR** to circuit-breaker shunt trip for power shutdown, **as directed**.
- L. Digital Alarm Communicator Transmitter

1. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
2. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture one **OR** two, **as directed**, telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either, **as directed**, line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
3. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - a. Verification that both telephone lines are available.
 - b. Programming device.
 - c. LED display.
 - d. Manual test report function and manual transmission clear indication.
 - e. Communications failure with the central station or fire-alarm control unit.
4. Digital data transmission shall include the following:
 - a. Address of the alarm-initiating device.
 - b. Address **OR** Zone, **as directed**, of the supervisory signal.
 - c. Address **OR** Zone, **as directed**, of the trouble-initiating device.
 - d. Loss of ac supply or loss of power.
 - e. Low battery.
 - f. Abnormal test signal.
 - g. Communication bus failure.
5. Secondary Power: Integral rechargeable battery and automatic charger.
6. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

M. Radio Alarm Transmitter

1. Transmitter shall comply with NFPA 1221 and shall be listed and labeled by an NRTL.
2. Comply with 47 CFR 90.
3. Description: Manufacturer's standard commercial product; factory assembled, wired, tested, and ready for installation and operation.
 - a. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
 - b. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by the Owner.
 - c. Normal Power Input: 120-V ac.
 - d. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
 - e. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand **100 mph (160 km/h)**, **as directed**, with a gust factor of 1.3 without failure.
 - f. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.
 - g. Antenna-Cable Connectors: Weatherproof.
 - h. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.
4. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-

reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:

- a. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
- b. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
- c. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
- d. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
- e. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
- f. Local Fire-Alarm-System Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm, **as directed**.

N. System Printer

1. Printer shall be listed and labeled by an NRTL as an integral part of fire-alarm system.

O. Device Guards

1. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
 - a. Factory fabricated and furnished by manufacturer of device.
 - b. Finish: Paint of color to match the protected device.

1.3 EXECUTION

A. Equipment Installation

1. Comply with NFPA 72 for installation of fire-alarm equipment.
2. Equipment Mounting: Install fire-alarm control unit on concrete base with tops of cabinets not more than **72 inches (1830 mm)** above the finished floor. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
 - a. Install seismic bracing. Comply with requirements in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
 - 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 concrete base.
 - c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - d. Place and secure anchorage devices. Use 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.
3. Equipment Mounting: Install fire-alarm control unit on finished floor with tops of cabinets not more than **72 inches (1830 mm)** above the finished floor.
 - a. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
4. Install wall-mounted equipment, with tops of cabinets not more than **72 inches (1830 mm)** above the finished floor.
 - a. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
5. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
 - a. Connect new equipment to existing control panel in existing part of the building.
 - b. Connect new equipment to existing monitoring equipment at the supervising station.

- c. Expand, modify, and supplement existing control **OR** monitoring, **as directed**, equipment as necessary to extend existing control **OR** monitoring, **as directed**, functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
 6. Smoke- or Heat-Detector Spacing:
 - a. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
 - b. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
 - c. Smooth ceiling spacing shall not exceed **30 feet (9 m)**
 - d. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A or Appendix B in NFPA 72.
 - e. HVAC: Locate detectors not closer than **3 feet (1 m) OR 5 feet (1.5 m)**, **as directed**, from air-supply diffuser or return-air opening.
 - f. Lighting Fixtures: Locate detectors not closer than **12 inches (300 mm)** from any part of a lighting fixture.
 7. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
 8. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.
 9. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
 10. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
 11. Audible Alarm-Indicating Devices: Install not less than **6 inches (150 mm)** below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
 12. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least **6 inches (150 mm)** below the ceiling.
 13. Device Location-Indicating Lights: Locate in public space near the device they monitor.
 14. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than **72 inches (1830 mm)** above the finished floor.
 15. Annunciator: Install with top of panel not more than **72 inches (1830 mm)** above the finished floor.
 16. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that will resist **100-mph (160-km/h)**, **as directed**, wind load with a gust factor of 1.3 without damage.
- B. Connections
 1. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware". Connect hardware and devices to fire-alarm system.
 - a. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
 2. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than **3 feet (1 m)** from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - a. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.
 - b. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
 - c. Smoke dampers in air ducts of designated air-conditioning duct systems.
 - d. Alarm-initiating connection to elevator recall system and components.
 - e. Alarm-initiating connection to activate emergency lighting control.
 - f. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.

- g. Supervisory connections at valve supervisory switches.
 - h. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
 - i. Supervisory connections at elevator shunt trip breaker.
 - j. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
 - k. Supervisory connections at fire-pump engine control panel.
- C. Identification
 - 1. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".
 - 2. Install framed instructions in a location visible from fire-alarm control unit.
- D. Grounding
 - 1. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- E. Field Quality Control
 - 1. Field tests shall be witnessed by authorities having jurisdiction.
 - 2. Tests and Inspections:
 - a. Visual Inspection: Conduct visual inspection prior to testing.
 - 1) Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
 - 2) Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - b. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - c. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - d. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 - e. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - f. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - 3. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
 - 4. Fire-alarm system will be considered defective if it does not pass tests and inspections.
 - 5. Prepare test and inspection reports.
 - 6. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
 - 7. Annual Test and Inspection: One year after date of Final Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

END OF SECTION 28 46 21 17

SECTION 28 46 21 17a - ZONED (DC LOOP) FIRE-ALARM SYSTEM

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for zoned (DC loop) fire alarm system. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Fire-alarm control unit.
 - b. Manual fire-alarm boxes.
 - c. System smoke detectors.
 - d. Nonsystem smoke detectors.
 - e. Heat detectors.
 - f. Notification appliances.
 - g. Magnetic door holders.
 - h. Remote annunciator.
 - i. Digital alarm communicator transmitter.
 - j. Radio alarm transmitter.

C. Definitions

1. LED: Light-emitting diode.
2. NICET: National Institute for Certification in Engineering Technologies.

D. System Description

1. Noncoded system, dedicated to fire-alarm service only.

E. Submittals

1. General Submittal Requirements:
 - a. Submittals shall be approved by authorities having jurisdiction prior to submitting them to the Owner.
 - b. Shop Drawings shall be prepared by persons with the following qualifications:
 - 1) Trained and certified by manufacturer in fire-alarm system design.
 - 2) NICET-certified fire-alarm technician, Level III **OR** Level IV **OR** one who meets the requirements necessary for certification, **as directed**, minimum.
 - 3) Licensed or certified by authorities having jurisdiction.
2. Product Data: For each type of product indicated.
3. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
 - a. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
 - b. Include voltage drop calculations for notification appliance circuits.
 - c. Include battery size calculations.
 - d. Include performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - e. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.

- f. Include floor plans to indicate final outlet locations showing zone designation of each device. Show size and route of cable and conduits.
 4. Delegated-Design Submittal: For smoke and heat detectors 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. Drawings showing the location of each smoke and heat detector, the ratings of each, and installation details as needed to comply with the listing conditions of the detector.
 - b. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.
 5. Qualification Data: For qualified Installer.
 6. Field quality-control reports.
 7. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. Deliver copies to authorities having jurisdiction, **as directed**, and include the following:
 - a. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - b. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
 - c. Record copy of site-specific software.
 - d. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - 1) Frequency of testing of installed components.
 - 2) Frequency of inspection of installed components.
 - 3) Requirements and recommendations related to results of maintenance.
 - 4) Manufacturer's user training manuals.
 - e. Manufacturer's required maintenance related to system warranty requirements.
 - f. Abbreviated operating instructions for mounting at fire-alarm control unit.
 - g. Copy of NFPA 25.
- F. Quality Assurance
 1. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
 2. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II **OR** Level III **OR** Level IV **OR** one who meets the requirements necessary for certification, **as directed**, technician.
 3. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.
 4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Project Conditions
 1. Interruption of Existing Fire-alarm Service: Do not interrupt fire-alarm service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
 - a. Notify the Owner no fewer than two days in advance of proposed interruption of fire-alarm service.
 - b. Do not proceed with interruption of fire-alarm service without the Owner 's written permission.
- H. Sequencing And Scheduling
 1. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

2. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.2 PRODUCTS

A. Systems Operational Description

1. Fire-alarm signal initiation shall be by one or more of the following devices and systems, **as directed**:
 - a. Manual stations.
 - b. Heat detectors.
 - c. Smoke detectors.
 - d. Duct smoke detectors.
 - e. Automatic sprinkler system water flow.
 - f. Fire-extinguishing system operation.
 - g. Fire standpipe system.
2. Fire-alarm signal shall initiate the following actions:
 - a. Continuously operate alarm notification appliances.
 - b. Identify alarm zone at fire-alarm control unit and remote annunciators, **as directed**.
 - c. Transmit an alarm signal to the remote alarm receiving station.
3. Supervisory signal initiation shall be by one or more of the following devices and systems:
 - a. Valve supervisory switch.
4. System trouble signal initiation shall be by one or more of the following devices and actions:
 - a. Open circuits, shorts, and grounds in designated circuits.
 - b. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 - c. Loss of primary power at fire-alarm control unit.
 - d. Ground or a single break in fire-alarm control unit internal circuits.
 - e. Abnormal ac voltage at fire-alarm control unit.
 - f. Break in standby battery circuitry.
 - g. Failure of battery charging.
 - h. Abnormal position of any switch at fire-alarm control unit or annunciator, **as directed**.
5. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators, **as directed**.

B. Fire-Alarm Control Unit

1. General Requirements for Fire-Alarm Control Unit:
 - a. Modular, power-limited design with electronic modules, UL 864 listed.
 - 1) Include a real-time clock for time annotation of events.
2. Alphanumeric Display and System Controls: Display alarm, supervisory, and component status messages and the programming and control menu.
 - a. Annunciator and Display: Liquid-crystal type, one line of 40 **OR** 80, **as directed**, characters, minimum.
3. Circuits:
 - a. No Fewer Than Five Initiating Device Circuits:
 - 1) Four circuits, NFPA 72, Class B.
 - 2) One circuit(s), NFPA 72, Class A, Style 6
 - b. No Fewer Than Two Notification Appliance Circuits: NFPA 72, Class B, Style Y.
4. Notification Appliance Circuit: Operation shall sound in a **<Insert pattern>**.
5. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be **OR** not be, **as directed**, connected to fire-alarm system.
6. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
7. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals **OR**

supervisory and digital alarm communicator transmitters **OR** digital alarm radio transmitters, **as directed**, shall be powered by the 24-V dc source.

- a. Alarm current draw of the entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
8. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 - a. Batteries: Sealed lead calcium **OR** Sealed, valve-regulated, recombinant lead acid **OR** Vented, wet-cell pocket, plate nickel cadmium, **as directed**.
9. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

C. Manual Fire-Alarm Boxes

1. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 - a. Single-action mechanism, breaking-glass or plastic-rod **OR** pull-lever, **as directed**, type.
 - b. Double-action mechanism requiring two actions to initiate an alarm, breaking-glass or plastic-rod **OR** pull-lever, **as directed**, type.
 - c. Station Reset: Key- or wrench-operated switch.
 - d. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
 - e. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

D. System Smoke Detectors

1. General Requirements for System Smoke Detectors:
 - a. Operating at 24-V dc, nominal.
 - b. Detectors shall be four **OR** two, **as directed**, -wire type.
 - c. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - d. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - e. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status, **as directed**.
 - f. Provide multiple levels of detection sensitivity for each sensor, with alarm-verification feature, **as directed**.
2. Photoelectric Smoke Detectors: Comply with UL 268.
3. Ionization Smoke Detector: Comply with UL 268.
4. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
 - a. Remote indication and test, **as directed**, station. Operating key switch initiates an alarm test, **as directed**.
 - b. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
 - c. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 - d. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

E. Nonsystem Smoke Detectors

1. Single-Station Smoke Detectors:

- a. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device, **as directed**.
- b. Auxiliary Relays: One Form C rated at 0.5 A **OR** Form A and one Form C, both rated at 0.5 A, **as directed**.
- c. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at **10 feet (3 m)** according to UL 464.
- d. Visible Notification Appliance: 177-cd strobe.
- e. Heat sensor, **135 deg F (57 deg C)** combination rate-of-rise and fixed temperature, **as directed**.
- f. Test Switch: Push-to-test; simulates smoke at rated obscuration.
- g. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
- h. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
- i. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
- j. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status, **as directed**.
- 2. Single-Station Duct Smoke Detectors:
 - a. Comply with UL 268A; operating at 120-V ac.
 - b. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to air duct. Provide terminals in the fixed base for connection to building wiring.
 - 1) Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
 - c. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 - d. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.
- F. Heat Detectors
 - 1. General Requirements for Heat Detectors: Comply with UL 521.
 - 2. Heat Detector, Combination Type: Actuated by either a fixed temperature of **135 deg F (57 deg C)** or a rate of rise that exceeds **15 deg F (8 deg C)** per minute unless otherwise indicated.
 - a. Mounting: Adapter plate for outlet box mounting **OR** Twist-lock base interchangeable with smoke-detector bases, **as directed**.
 - 3. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of **190 deg F (88 deg C)**.
 - a. Mounting: Adapter plate for outlet box mounting **OR** Twist-lock base interchangeable with smoke-detector bases, **as directed**.
- G. Notification Appliances
 - 1. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
 - a. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
 - 2. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.
 - 3. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured **10 feet (3 m)** from the horn, using the coded signal prescribed in UL 464 test protocol.

4. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum **1-inch- (25-mm-)** high letters on the lens.
 - a. Rated Light Output:
 - 1) Indicated on Drawings.
 - 2) **15 OR 30 OR 75 OR 110 OR 177, as directed, cd.**
OR
 15/30/75/110 cd, selectable in the field.
 - b. Mounting: Indicated on Drawings **OR** Wall mounted, **as directed**.
 - c. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 - d. Flashing shall be in a temporal pattern, synchronized with other units.
 - e. Strobe Leads: Factory connected to screw terminals.
 - f. Mounting Faceplate: Factory finished, red **OR** white, **as directed**.
- H. Magnetic Door Holders
 1. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
 - a. Electromagnet: Requires no more than 3 W to develop **25-lbf (111-N)** holding force.
 - b. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 - c. Rating: 24-V ac or dc.
 - d. Rating: 120-V ac.
 2. Material and Finish: Match door hardware.
- I. Remote Annunciator
 1. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
 - a. Mounting: Flush **OR** Surface, **as directed**, cabinet, NEMA 250, Type 1.
 2. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.
- J. Digital Alarm Communicator Transmitter
 1. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
 2. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture one **OR** two, **as directed**, telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either, **as directed**, line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
 3. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - a. Verification that both telephone lines are available.
 - b. Programming device.
 - c. LED display.
 - d. Manual test report function and manual transmission clear indication.
 - e. Communications failure with the central station or fire-alarm control unit.
 4. Digital data transmission shall include the following:
 - a. Zone of the alarm initiating device.
 - b. Zone of the supervisory signal.
 - c. Zone of the trouble initiating device.

- d. Loss of ac supply or loss of power.
- e. Low battery.
- f. Abnormal test signal.
- g. Communication bus failure.
- 5. Secondary Power: Integral rechargeable battery and automatic charger.
- 6. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

K. Radio Alarm Transmitter

- 1. Transmitter shall comply with NFPA 1221 and shall be listed and labeled by an NRTL.
- 2. Comply with 47 CFR 90.
- 3. Description: Manufacturer's standard commercial product; factory assembled, wired, tested, and ready for installation and operation.
 - a. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
 - b. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by the Owner.
 - c. Normal Power Input: 120-V ac.
 - d. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
 - e. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mph (160 km/h) with a gust factor of 1.3 without failure.
 - f. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.
 - g. Antenna-Cable Connectors: Weatherproof.
 - h. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.
- 4. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:
 - a. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
 - b. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
 - c. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
 - d. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
 - e. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
 - f. Local Fire-Alarm-System Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm, **as directed**.

L. Device Guards

- 1. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
 - a. Factory fabricated and furnished by manufacturer of the device.
 - b. Finish: Paint of color to match the protected device.

1.3 EXECUTION

A. Equipment Installation

1. Comply with NFPA 72 for installation of fire-alarm equipment.
2. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
 - a. Connect new equipment to the existing control panel in the existing part of the building.
 - b. Connect new equipment to the existing monitoring equipment at the supervising station.
 - c. Expand, modify, and supplement the existing control **OR** monitoring, **as directed**, equipment as necessary to extend the existing control **OR** monitoring, **as directed**, functions to the new points. New components shall be capable of merging with the existing configuration without degrading the performance of either system.
3. Smoke- or Heat-Detector Spacing:
 - a. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
 - b. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
 - c. Smooth ceiling spacing shall not exceed **30 feet (9 m)**, **as directed**.
 - d. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A or Appendix B, **as directed**, in NFPA 72.
 - e. HVAC: Locate detectors not closer than **3 feet (1 m) OR 5 feet (1.5 m)**, **as directed**, from air-supply diffuser or return-air opening.
 - f. Lighting Fixtures: Locate detectors not closer than **12 inches (300 mm)** from any part of a lighting fixture.
4. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
5. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.
6. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
7. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
8. Audible Alarm-Indicating Devices: Install not less than **6 inches (150 mm)** below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
9. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least **6 inches (150 mm)** below the ceiling.
10. Device Location-Indicating Lights: Locate in public space near the device they monitor.
11. Fire-Alarm Control Unit: Surface mounting, with tops of cabinets not more than **72 inches (1830 mm)** above the finished floor.
12. Annunciator: Install with top of panel not more than **72 inches (1830 mm)** above the finished floor.
13. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that will resist **100-mph (160-km/h)**, **as directed**, wind load with a gust factor of 1.3 without damage.

B. Connections

1. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware". Connect hardware and devices to fire-alarm system.
 - a. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

2. Connect supervised interface devices to the following devices and systems. Install the interface device less than **3 feet (1 m)** from the device controlled.
 - a. Smoke dampers in air ducts of designated air-conditioning duct systems.
 - b. Supervisory connections at valve supervisory switches.
 - c. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
 - d. Supervisory connections at fire-pump engine control panel.
- C. Identification
 1. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".
 2. Install framed instructions in a location visible from fire-alarm control unit.
- D. Grounding
 1. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- E. Field Quality Control
 1. Field tests shall be witnessed by authorities having jurisdiction.
 2. Tests and Inspections:
 - a. Visual Inspection: Conduct the visual inspection prior to testing.
 - 1) Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
 - 2) Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - b. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing, and Maintenance" Chapter in NFPA 72.
 - c. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - d. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - e. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 3. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
 4. Fire-alarm system will be considered defective if it does not pass tests and inspections.
 5. Prepare test and inspection reports.
 6. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
 7. Annual Test and Inspection: One year after date of Final Completion, test fire-alarm system complying with the visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

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Task	Specification	Specification Description
28 49 11 00	28 16 11 00	Perimeter Security
28 49 11 00	28 16 11 00a	Intrusion Detection

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SECTION 31 13 16 00 - SITE CLEARING

1.1 GENERAL

A. Description Of Work

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

B. Summary

1. Section Includes:
 - a. Protecting existing vegetation to remain.
 - b. Removing existing vegetation.
 - c. Clearing and grubbing.
 - d. Stripping and stockpiling topsoil.
 - e. Removing above- and below-grade site improvements.
 - f. Disconnecting, capping or sealing, and removing site utilities **OR** abandoning site utilities in place, **as directed**.
 - g. Temporary erosion- and sedimentation-control measures.

C. Definitions

1. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
OR
Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
2. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.
OR
Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than **2 inches (50 mm)** in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
3. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
OR
Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings **OR** defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated, **as directed**.
4. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

D. Material Ownership

1. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain the Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

E. Submittals

1. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - a. Use sufficiently detailed photographs or videotape.

- b. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.
 - 2. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

F. Quality Assurance

- 1. Preinstallation Conference: Conduct conference at Project site.

G. Project Conditions

- 1. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - a. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Owner and authorities having jurisdiction.
 - b. Provide alternate routes around closed or obstructed traffic ways if required by the Owner or authorities having jurisdiction.
- 2. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining the Owner's property will be obtained by the Owner before award of Contract.
 - a. Do not proceed with work on adjoining property until directed by the Owner.
- 3. Salvable Improvements: Carefully remove items indicated to be salvaged and store on the Owner's premises where indicated.
- 4. Utility Locator Service: Notify utility locator service **OR** Miss Utility **OR** Call Before You Dig **OR** Dig Safe System **OR** One Call, **as directed**, for area where Project is located before site clearing.
- 5. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.
- 6. The following practices are prohibited within protection zones:
 - a. Storage of construction materials, debris, or excavated material.
 - b. Parking vehicles or equipment.
 - c. Foot traffic.
 - d. Erection of sheds or structures.
 - e. Impoundment of water.
 - f. Excavation or other digging unless otherwise indicated.
 - g. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- 7. Do not direct vehicle or equipment exhaust towards protection zones.
- 8. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.
- 9. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

1.2 PRODUCTS

A. Materials

- 1. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving".
 - a. If soil backfill is required in below-grade areas after site clearing, obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.
- 2. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #79, Alkyd Anticorrosive Metal Primer **OR** SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating, **as directed**.
 - a. Use coating with a VOC content of **420 g/L (3.5 lb/gal.)** or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1.3 EXECUTION

A. Preparation

1. Protect and maintain benchmarks and survey control points from disturbance during construction.
 2. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag **OR** Wrap a **1-inch (25-mm)** blue vinyl tie tape flag around, **as directed**, each tree trunk at **54 inches (1372 mm)** above the ground.
 3. Protect existing site improvements to remain from damage during construction.
 - a. Restore damaged improvements to their original condition, as acceptable to the Owner.
- B. Temporary Erosion And Sedimentation Control
1. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
 2. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
 3. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
 4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- C. Tree And Plant Protection
1. General: Protect trees and plants remaining on-site according to requirements in Division 01 Section "Temporary Tree And Plant Protection".
 2. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by the Owner.
- D. Existing Utilities
1. the Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.
OR
Verify that utilities have been disconnected and capped before proceeding with site clearing.
 2. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.
 - a. Arrange with utility companies to shut off indicated utilities.
OR
the Owner will arrange to shut off indicated utilities when requested by Contractor.
 3. Locate, identify, and disconnect utilities indicated to be abandoned in place.
 4. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - a. Notify the Owner not less than two days in advance of proposed utility interruptions.
 - b. Do not proceed with utility interruptions without the Owner's written permission.
 5. Excavate for and remove underground utilities indicated to be removed.
OR
Removal of underground utilities is included in Division 21 OR Division 22 OR Division 23 OR Division 26 OR Division 28.
- E. Clearing And Grubbing
1. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
 - a. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 - b. Grind down stumps and remove roots, obstructions, and debris to a depth of **18 inches (450 mm)** below exposed subgrade.
 - c. Use only hand methods for grubbing within protection zones.
 - d. Chip removed tree branches and stockpile in areas approved by the Owner **OR** dispose of off-site, **as directed**.
 2. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

- a. Place fill material in horizontal layers not exceeding a loose depth of **8 inches (200 mm)**, and compact each layer to a density equal to adjacent original ground.

F. Topsoil Stripping

1. Remove sod and grass before stripping topsoil.
2. Strip topsoil to depth indicated on Drawings **OR** to depth of **6 inches (150 mm)**, **as directed**, in a manner to prevent intermingling with underlying subsoil or other waste materials.
 - a. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than **2 inches (50 mm)** in diameter; trash, debris, weeds, roots, and other waste materials.
3. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
 - a. Limit height of topsoil stockpiles to **72 inches (1800 mm)**.
 - b. Do not stockpile topsoil within protection zones.
 - c. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
 - d. Stockpile surplus topsoil to allow for respreading deeper topsoil.

G. Site Improvements

1. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
2. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 - a. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
 - b. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

H. Disposal Of Surplus And Waste Materials

1. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off the Owner's property.
2. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 31 13 16 00

SECTION 31 13 16 00a - 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 31 13 16 00a

SECTION 31 23 23 33 - EXCAVATION SUPPORT AND PROTECTION

1.1 GENERAL

A. Description Of Work

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

B. Performance Requirements

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

C. Submittals

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

D. Quality Assurance

1. Preinstallation Conference: Conduct conference at Project site.

E. Project Conditions

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

1.2 PRODUCTS

A. Materials

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

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

1.3 EXECUTION

A. Preparation

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

B. Soldier Piles And Lagging

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

C. Sheet Piling

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

D. Tiebacks

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

- b. Maintain tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.
- E. Bracing
- 1. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
 - a. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by the Owner.
 - b. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
 - c. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.
- F. Removal And Repairs
- 1. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
 - a. Remove excavation support and protection systems to a minimum depth of **48 inches (1200 mm)** below overlaying construction and abandon remainder.
 - b. Fill voids immediately with approved backfill compacted to density specified in Division 31 Section "Earth Moving".
 - c. Repair or replace, as approved by the Owner, adjacent work damaged or displaced by removing excavation support and protection systems.
 - 2. Leave excavation support and protection systems permanently in place.

END OF SECTION 31 23 23 33

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SECTION 31 23 23 33a - EARTHWORK

1.1 GENERAL

A. Description Of Work

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

B. Summary

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

C. Definitions

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

- b. Bulk Excavation: Late-model, track-mounted loader; rated at not less than **230-hp (172-kW)** flywheel power and developing a minimum of **47,992-lbf (213.3-kN)** breakout force with a general-purpose bare bucket; measured according to SAE J-732.
- 9. If Standard Penetration Values are used to Define Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material **3/4 cu. yd. (0.57 cu. m)** or more in volume that exceed a standard penetration resistance of **100 blows/2 inches (97 blows/50 mm)** when tested by a geotechnical testing agency, according to ASTM D 1586.
- 10. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- 11. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- 12. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- 13. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

D. Submittals

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

E. Quality Assurance

- 1. Blasting:
 - a. Blasting will not be allowed.

OR

Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:

 - 1) Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
 - 2) Seismographic monitoring during blasting operations.
- 2. Seismic Survey Agency: An independent testing agency, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:
 - a. Report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.

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

F. Project Conditions

1. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
 - a. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Owner and authorities having jurisdiction.
 - b. Provide alternate routes around closed or obstructed traffic ways if required by the Owner or authorities having jurisdiction.
2. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining the Owner's property will be obtained by the Owner before award of Contract.
3. Do not proceed with work on adjoining property until directed by the Owner.
4. Utility Locator Service: Notify utility locator service **OR** "Miss Utility" **OR** "Call Before You Dig" **OR** "Dig Safe System" **OR** "One Call", **as directed**, for area where Project is located before beginning earth moving operations.
5. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 01 Section(s) "Temporary Facilities And Controls" **OR** Division 31 Section(s) "Site Clearing", **as directed**, are in place.
6. Do not commence earth moving operations until plant-protection measures specified in Division 01 Section "Temporary Tree And Plant Protection" are in place.
7. The following practices are prohibited within protection zones:
 - a. Storage of construction materials, debris, or excavated material.
 - b. Parking vehicles or equipment.
 - c. Foot traffic.
 - d. Erection of sheds or structures.
 - e. Impoundment of water.
 - f. Excavation or other digging unless otherwise indicated.
 - g. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
8. Do not direct vehicle or equipment exhaust towards protection zones.
9. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

1.2 PRODUCTS

A. Soil Materials

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

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

B. Geotextiles

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

C. Controlled Low-Strength Material

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

OR

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

D. Geofoam

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

E. Accessories

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

OR

Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:

 - f. Red: Electric.
 - g. Yellow: Gas, oil, steam, and dangerous materials.
 - h. Orange: Telephone and other communications.
 - i. Blue: Water systems.
 - j. Green: Sewer systems.

1.3 EXECUTION

A. Preparation

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

B. Dewatering

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

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

C. Explosives

1. Explosives: Do not use explosives.

OR

Explosives: Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.

- a. Perform blasting without damaging adjacent structures, property, or site improvements.
- b. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

D. Excavation, General

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

- E. Excavation For Structures
1. Excavate to indicated elevations and dimensions within a tolerance of plus or minus **1 inch (25 mm)**. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - a. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
 - b. Pile Foundations: Stop excavations **6 to 12 inches (150 to 300 mm)** above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
 - c. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus **1 inch (25 mm)**. Do not disturb bottom of excavations intended as bearing surfaces.
 2. Excavations at Edges of Tree- and Plant-Protection Zones:
 - a. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 - b. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree And Plant Protection".
- F. Excavation For Walks And Pavements
1. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.
- G. Excavation For Utility Trenches
1. Excavate trenches to indicated gradients, lines, depths, and elevations.
 - a. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
 2. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to **12 inches (300 mm)** higher than top of pipe or conduit unless otherwise indicated.
 - a. Clearance: **12 inches (300 mm)** each side of pipe or conduit **OR** As indicated, **as directed**.
 3. Trench Bottoms (if a bedding course is not required under pipe and conduit): Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 - a. For pipes and conduit less than **6 inches (150 mm)** in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 - b. For pipes and conduit **6 inches (150 mm)** or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
 - c. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
 - d. Excavate trenches **6 inches (150 mm)** deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
 4. Trench Bottoms (if a bedding course is required under pipe and conduit): Excavate trenches **4 inches (100 mm)** deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
 - a. Excavate trenches **6 inches (150 mm)** deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
 5. Trenches in Tree- and Plant-Protection Zones:
 - a. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

- b. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
 - c. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree And Plant Protection".
- H. Excavation For Elevator Cylinder
 - 1. Drill well hole plumb in elevator pit to accommodate installation of elevator-cylinder assembly. Coordinate with applicable requirements for diameter and tolerances in Division 14 Section(s) "Hydraulic Elevators" OR "Hydraulic Freight Elevators", **as directed**.
 - 2. Provide well casing as necessary to retain walls of well hole.
- I. Subgrade Inspection
 - 1. Notify the Owner when excavations have reached required subgrade.
 - 2. If the Owner determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
 - 3. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than **15 tons (13.6 tonnes)** to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - a. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to **3 mph (5 km/h)**.
 - b. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Owner, and replace with compacted backfill or fill as directed.
 - 4. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 - 5. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Owner, without additional compensation.
- J. Unauthorized Excavation
 - 1. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of **2500 psi (17.2 MPa)**, may be used when approved by the Owner.
 - a. Fill unauthorized excavations under other construction, pipe, or conduit as directed by the Owner.
- K. Storage Of Soil Materials
 - 1. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - a. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
- L. Backfill
 - 1. Place and compact backfill in excavations promptly, but not before completing the following:
 - a. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 - b. Surveying locations of underground utilities for Record Documents.
 - c. Testing and inspecting underground utilities.
 - d. Removing concrete formwork.
 - e. Removing trash and debris.
 - f. Removing temporary shoring and bracing, and sheeting.
 - g. Installing permanent or temporary horizontal bracing on horizontally supported walls.
 - 2. Place backfill on subgrades free of mud, frost, snow, or ice.
- M. Utility Trench Backfill
 - 1. Place backfill on subgrades free of mud, frost, snow, or ice.

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

N. Soil Fill

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

O. Geofoam Fill

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

P. Soil Moisture Control

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

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

Q. Compaction Of Soil Backfills And Fills

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

R. Grading

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

S. Subsurface Drainage

- 1. Subdrainage Pipe: Specified in Division 33 Section "Storm Utility Drainage Piping".
- 2. Subsurface Drain: If nonwoven geotextile is used in subsurface drainage applications, place subsurface drainage geotextile around perimeter of subdrainage trench. Place a **6-inch (150-mm)** course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of **12 inches (300 mm)** of filter material, placed in compacted layers **6 inches (150 mm)** thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least **6 inches (150 mm)**.
 - a. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 **OR** with a minimum of two passes of a plate-type vibratory compactor, **as directed**.
- 3. Drainage Backfill: If using free-draining granular backfill against walls, place and compact filter material over subsurface drain, in width indicated, to within **12 inches (300 mm)** of final subgrade, in compacted layers **6 inches (150 mm)** thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least **6 inches (150 mm)**.
 - a. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 **OR** with a minimum of two passes of a plate-type vibratory compactor, **as directed**.

- b. Place and compact impervious fill over drainage backfill in **6-inch- (150-mm-)** thick compacted layers to final subgrade.
- T. Subbase And Base Courses Under Pavements And Walks
- 1. Place subbase course and base course, **as directed**, on subgrades free of mud, frost, snow, or ice.
 - 2. On prepared subgrade, place subbase course and base course, **as directed**, under pavements and walks as follows:
 - a. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 - b. Place base course material over subbase course under hot-mix asphalt pavement.
 - c. Shape subbase course and base course, **as directed**, to required crown elevations and cross-slope grades.
 - d. Place subbase course and base course, **as directed**, **6 inches (150 mm)** or less in compacted thickness in a single layer.
 - e. Place subbase course and base course, **as directed**, that exceeds **6 inches (150 mm)** in compacted thickness in layers of equal thickness, with no compacted layer more than **6 inches (150 mm)** thick or less than **3 inches (75 mm)** thick.
 - f. Compact subbase course and base course, **as directed**, at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698 **OR** ASTM D 1557, **as directed**.
 - 3. Pavement Shoulders: Place shoulders along edges of subbase course and base course, **as directed**, to prevent lateral movement. Construct shoulders, at least **12 inches (300 mm)** wide, of satisfactory soil materials and compact simultaneously with each subbase and base, **as directed**, layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698 **OR** ASTM D 1557, **as directed**.
- U. Drainage Course Under Concrete Slabs-On-Grade
- 1. Place drainage course on subgrades free of mud, frost, snow, or ice.
 - 2. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
 - a. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 - b. Place drainage course **6 inches (150 mm)** or less in compacted thickness in a single layer.
 - c. Place drainage course that exceeds **6 inches (150 mm)** in compacted thickness in layers of equal thickness, with no compacted layer more than **6 inches (150 mm)** thick or less than **3 inches (75 mm)** thick.
 - d. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.
- V. Field Quality Control
- 1. Special Inspections: If special inspections are required by code, engage a qualified special inspector to perform the following special inspections:
 - a. Determine prior to placement of fill that site has been prepared in compliance with requirements.
 - b. Determine that fill material and maximum lift thickness comply with requirements.
 - c. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.
 - 2. Testing Agency: Engage a qualified geotechnical engineering testing agency to perform tests and inspections.
 - 3. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
 - 4. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing

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

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

W. Protection

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

X. Disposal Of Surplus And Waste Materials

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

END OF SECTION 31 23 23 33a

SECTION 31 24 13 00 - EMBANKMENT

1.1 GENERAL

A. Description Of Work

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

B. Submittals

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

C. Definitions

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

D. Sampling And Testing

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

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

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

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

4. Field Testing Facilities at Subbase Mixing Plant: Field-testing facilities for the purpose of testing subbase course material at the mixing plant shall be provided by the Contractor's soil-testing service.

5. Reports: No soil material shall be used until soil test reports have been reviewed and approved.

6. Evaluation of Test Results

- Soil materials of any classification shall not have a moisture content at the time of compaction that would be classified as unsatisfactory soil materials in the paragraph entitled, "Definitions."
- Results of density of soil-in-place tests shall be considered satisfactory if the average of any group of four consecutive density tests which may be selected is in each instance equal to or greater than the specified density, and if no density test has a value more than 2 percentage points below the specified density.

E. Use Of Explosives:

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

F. Protection Of Persons And Property

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

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

H. Existing Conditions

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

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

1.2 PRODUCTS

A. Materials

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

1.3 EXECUTION

A. Blasting:

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

OR

Blasting is not required or permitted.

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

C. Excavation

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

- and filling shall be performed in a manner and sequence that will provide proper drainage at all times. Material required for fill or embankment in excess of that produced by excavation within the grading limits shall be excavated from the borrow areas indicated or from other approved areas selected by the Owner.
4. **Excavation of Ditches, Gutters, and Channels:** Care shall be taken not to excavate ditches and gutters below grades shown. Excessive open-ditch or gutter excavation shall be backfilled with suitable materials to grades indicated at no additional cost. Materials excavated shall be disposed as indicated, except that in no case shall material be deposited less than **3 ft. (1 m)** from the edge of a ditch. Contractor shall maintain excavations free from debris until final acceptance of the work.
 5. **Excavation for Drainage Structures**
 - a. Dimensions and elevations of footings and foundation excavations indicated are only approximate and may be changed if necessary to ensure adequate foundation support. Trenches and foundation pits shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations. Rock or other hard foundation material shall be cleaned of loose debris and cut to a firm surface, either level, stepped, or serrated. Loose disintegrated rock and thin strata shall be removed. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before concrete or masonry is to be placed.
 - b. Where pile foundations are to be used, the excavation of each pit shall be stopped at an elevation **1 ft. (300 mm)** above the base of the footing, as specified, before piles are driven. After pile driving has been completed, loose and displaced material shall be removed and excavation completed, leaving a smooth, solid, undisturbed surface to receive concrete or masonry.
 6. **Protection or Removal of Utility Lines:** Existing Utilities that are indicated to be retained, or the locations of which have been ascertained from the Owner utility drawings, as well as utility lines encountered during excavation, shall be protected from damage during excavation and backfilling. However, reliance on the information obtained from the Owner drawings does not absolve the Contractor of responsibility for damages, so careful hand methods shall be used to verify the location of underground utilities. Damage shall be reported immediately and satisfactorily repaired by the Contractor at no additional cost. The Contractor shall provide sketches of existing conditions if there are variances, as well as any modifications, on "as-built" drawings. When utility lines that are to be removed are encountered within the area of operations, the Contractor shall give notice in ample time for the necessary measures to be taken to prevent interruption of service.
- D. **Classification Of Excavation:** Excavations specified shall be done on either a classified or unclassified basis as provided for under the item designations of the Contract.
- E. **Utilization Of Excavation Materials:** Unsatisfactory materials removed from excavations shall be disposed in designated areas. Satisfactory material removed from excavations shall be used, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding; as backfill; and for similar purposes. No satisfactory excavated material shall be wasted without specific written authorization. Satisfactory material authorized to be wasted shall be disposed in designated areas approved for surplus material storage or designated waste areas as directed. Coarse rock from excavations shall be stockpiled and used for constructing slopes of embankments adjacent to streams, for constructing slopes or sides and bottoms of channels, and for protecting against erosion. Hand placing of coarse rock from excavations will not be required. Excavated material shall not be disposed in a manner as to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.
- F. **Selection Of Borrow Material:** Borrow material shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Borrow material shall be obtained from the borrow areas indicated on the plans or from other approved sources, either private or within the limits of the project site, selected by the Contractor. Unless otherwise provided in the

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

- G. **Opening And Drainage Of Excavation And Borrow Pits:** The Contractor shall give notice sufficiently in advance of the opening of any excavation or borrow pit to permit elevations and measurements of the undisturbed ground surface to be taken. Unless otherwise permitted, borrow pits and other excavation areas shall be excavated in such manner as will afford adequate drainage. Overburden and other spoil material shall be transported to designated spoil areas or otherwise disposed as directed. Borrow pits shall be neatly trimmed and left in such shape as will facilitate accurate measurements after the excavation is completed.
- H. **Grading Areas:** When so provided and indicated, work under contract will be divided into grading areas, within which satisfactory excavated material shall be placed in embankments, fills, and required backfills. Contractor shall not haul satisfactory material excavated in one grading area to another grading area, except when so directed in writing.
- I. **Preparation Of Ground Surface For Embankments**
 - 1. Ground surface on which fill is to be placed shall be stripped of live, dead, or decayed vegetation, rubbish, debris, and other unsatisfactory material; shall be plowed, disked, or otherwise broken up; pulverized; moistened or aerated as necessary; mixed; and compacted to at least 90 percent maximum density for cohesive materials or 100 percent maximum density for cohesionless materials.
 - 2. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment. The prepared ground surface shall be scarified and moistened or aerated just prior to placement of embankment materials to ensure adequate bond between embankment material and the prepared ground surface.
- J. **Embankments**
 - 1. **Earth Embankments**
 - a. Earth embankments shall be constructed from satisfactory materials free of organic or frozen material and rocks with maximum dimensions not greater than **3 in. (75 mm)**. The material shall be placed in successive horizontal layers of loose material not more than **6 in. (150 mm)** in depth. Each layer shall be spread uniformly on a prepared surface, i.e., a soil surface that has been moistened or aerated and scarified plowed, disked, or otherwise broken up in such a manner that the fill will bond with the surface on which it is placed, mixed, and compacted to at least 90 percent maximum density for borrow materials or 100 percent maximum density for excavated materials. Compaction requirements for the upper portion of earth embankments forming subgrade for pavements shall be identical to those requirements specified in paragraph entitled, "Subgrade Preparation."
 - b. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment.
 - 2. **Rock Embankments**
 - a. Rock embankments shall be constructed from material essentially classified as rock excavation, placed in successive horizontal layers of loose material not more than **8 to 10 in. (200 to 250 mm)** in depth. Pieces of rock larger than **8 to 10 in. (200 to 250 mm)** in greatest dimension shall not be used.
 - b. Each layer of material shall be spread uniformly and shall be completely saturated and compacted to density as directed by the Owner.

- c. Each layer of material shall be spread uniformly and shall be completely saturated and compacted until the interstices are filled with well-compacted materials and the entire layer is a dense, compacted mass.
 - d. Each successive layer of material shall adequately bond to the material on which it is placed.
 - e. Compaction shall be accomplished with vibratory compactors with a minimum static weight of **20,000 lbs. (90 kN)**, heavy rubber-tired rollers weighing not less than **25,000 lbs. (110 kN)** or steel-wheeled rollers with a loaded weight of not less than **4,000 lb/ft (58,400 N/m)** of drum length.
 - f. Rock shall not be used above a point **6 in. (150 mm)** below the surface of an embankment that is to be paved.
- K. Subgrade Preparation
 - 1. Construction
 - a. Subgrade shall be shaped to line, grade, and cross section and compacted as specified. This operation shall include plowing, disking, and any moistening or aerating required to obtain proper compaction. Soft or otherwise unsatisfactory material shall be removed and replaced with satisfactory excavated material or other approved material as directed. Rock encountered in the cut sections shall be excavated to a depth of **6 in. (150 mm)** below finished grade for the subgrade. Low areas resulting from removal of unsatisfactory material or excavation of rock shall be brought up to required grade with satisfactory materials, and the entire subgrade shall be shaped to line, grade, and cross section and compacted as specified.
 - b. After rolling, the surface of the subgrade for roadways and/or airfields shall indicate a deviation not greater than **3/8 in. (10 mm)** when tested with a **10-ft (3.0 m)** straightedge applied both parallel with, and at right angles to, the centerline of the area.
 - c. Elevation of the finished subgrade shall vary not more than **1/4-in. (6 mm)** from the established grade and approved cross section.
 - 2. Compaction: Compaction for pavements and shoulders shall be accomplished with approved equipment until the layer is compacted to the full depth to at least 95 percent maximum density.
- L. Shoulder Construction: Shoulders shall be constructed of satisfactory excavated or borrow materials or as otherwise indicated on the plans. Shoulders shall be constructed as soon as possible after adjacent paving is complete, but in the case of rigid pavements, shoulders shall not be constructed until permission has been obtained. The entire shoulder area shall be compacted to at least the percentage of maximum density as specified for specific ranges of depth below the surface of the shoulder. Compaction shall be accomplished with approved equipment. Shoulder construction shall be done in proper sequence in such a manner that adjacent ditches will be drained effectively and no damage of any kind is done to the adjacent, completed pavement. The completed shoulders shall be true to alignment and grade and shaped to drain in conformity with the cross section indicated.
- M. Finishing: Surface of excavations, embankments, and subgrades shall be finished to a reasonably smooth and compact surface substantially in accordance with the lines, grades, and cross sections or elevations indicated. Degree of finish for graded areas shall be within **1/10 ft (30 mm)** of the grades and elevations indicated, except that the degree of finish for subgrades shall be as specified. Gutters and ditches shall be finished as indicated. Surface of areas to be turfed shall be finished to a smoothness suitable for the application of turfing materials.
- N. Subgrade And Embankment Protection: During construction, embankments and excavations shall be kept shaped and drained. Ditches and drains along subgrade shall be maintained in such a manner as to drain effectively at all times. Finished subgrade shall not be disturbed by traffic or other operations and shall be protected and maintained by the Contractor in a satisfactory condition until ballast, subbase, base, or pavement is placed. Storage or stockpiling materials on finished subgrade will not be permitted. Subbase, base course, ballast, or pavement shall not be laid until the subgrade has been checked and approved, and in no case shall subbase, base, surfacing, pavement, or ballast be placed on a muddy, spongy, or frozen subgrade.

END OF SECTION 31 24 13 00

SECTION 31 24 13 00a - LEVEE CLOSURE

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing of labor and materials for providing levee closures.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION

A. If there is deemed, by the Owner, to be considerable risk of flooding involved with removing drainage structures and gates in the existing Levee System, the Contractor shall perform the work of this contract as follows:

1. Only one drainage structure/flap gate will be allowed to be disrupted at one time. All proposed work at each drainage structure shall be completed before proceeding to the next structure.
2. The Contractor shall have all materials required for each structure installation secured on site, before beginning construction on that structure.
3. The Contractor shall have all necessary materials on site to temporarily plug existing and/or proposed piping through the levee.
4. Weather and river flow conditions shall be monitored at all times by the Contractor while each drainage structure is open to flow. The Contractor shall construct an adequate closure in a timely fashion to plug the drainage structure preventing flow through the levee.

END OF SECTION 31 24 13 00a

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Task	Specification	Specification Description
31 24 13 00	31 23 23 33a	Earthwork

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SECTION 32 31 13 13 - 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 32 31 13 13

Task	Specification	Specification Description
32 31 13 13	31 13 16 00a	Tree Protection And Trimming

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SECTION 33 05 07 13 - TRENCHLESS EXCAVATION USING MICROTUNNELING

1.1 GENERAL

A. Description Of Work

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

B. Design Requirements

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

C. Submittals: Submit the following:

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

D. Delivery, Storage, and Handling:

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

E. Quality Assurance

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

1.2 PRODUCTS

A. Piping Casing Materials

1. Ductile-Iron Piping

- a. Pipe and Fittings: Pipe, except flanged pipe, ANSI/AWWA C151/A21.51 Pressure Class and/or Thickness Class as required to meet Project requirements. The outside diameter of ductile iron microtunneling pipe shall be in accordance with AWWA C150/A21.50.
- b. Joints and Jointing Material: Joints: Pressure and gravity microtunneling pipe shall have either an integral-bell push-on or rubber gasket coupled joint meeting the following criteria:
 - 1) Integral-bell push-on joint microtunneling pile shall consist of a rubber-gasket joint manufactured to conform with AWWA C111/A21.11 and the dimensions shown in ANSI/AWWA C151/A21.51. The exterior of the pipe shall be coated with a durable cement-mortar or concrete coating applied in such a manner as to provide a uniform outside diameter.
 - 2) Cement-mortar or concrete strength, reinforcement and method of placement shall be in accordance with manufacturer's recommendations. Durable Coatings of other types may be substituted provided they maintain a uniform outside diameter and they are approved by the designer. Rubber gasket coupled microtunneling joint shall be manufactured so as to provide a joint which has the same nominal outside diameter as the pipe barrel.

2. Polyvinyl Chloride Pipe (PVC): ASTM F 794. ASTM D 3212 for gasketed joint systems. ASTM F 477 for gasket materials.

3. Reinforced Concrete Pipe

- a. Nominal dimensions: Typical nominal dimensions for reinforced concrete pipe are detailed in ASTM standards **ASTM C 76 (ASTM C 76M)**, **ASTM C 361 (ASTM C361M)**, **ASTM C 655 (ASTM C 655M)**, **ASTM C 822**. Pipe meeting these requirements is generally acceptable for jacking. The permissible variation allowed with respect to these and other dimensions shall be in accordance with the variations listed in the section.
- b. Joints and Jointing Material: Joint shall be formed entirely of concrete and as detailed in the contract drawings, may **OR** shall, **as directed**, utilize a rubber gasket or mastic to provide the seal. Incorporate an assembly of steel bands or steel bell ends and spigot rings and rubber gaskets in accordance with contract drawings.

4. Steel Pipe

- a. Steel pipe shall be in conformance with ASTM A 139, Grade B with a minimum yield strength of **35,000 psi (242 MPa)** **OR** AWWA C200 **OR** API SPEC 5L Grade B **OR** ASTM A 53 **OR** ASTM A 716 **OR** ASTM A 746, **as directed**. Steel pipe shall be welded, seamless, square cut with even lengths and shall comply of Articles 4.2, 4.3, and 4.4 of the API SPEC 5L.
- b. Joints: The connection of adjacent pieces of microtunneling steel pipe may be accomplished by field butt welding, internal weld sleeves, integral press fit connectors, as long as loading and installation design criteria are met.

5. Fiberglass Pipe

- a. Pipe: Fiberglass pipe shall meet the requirements of ASTM D 3262, Type 1, Liner 2, Grade 3. The method of the manufacture shall be centrifugal casting resulting in a controlled outside diameter. Minimum wall thickness shall be **+1.5 inches (+38 mm)**.
- b. Joints: The pipes shall be connected by gasket-sealed bell-spigot joints. The gasket material shall meet requirements of ASTM F 477. The joint shall meet the requirements of ASTM D 4161 and shall be leak-free under the following conditions:
 - 1) External pressures up to 2 bars, **29 psi (200 kPa)** from bentonite injection, slurry system operation or groundwater head.
 - 2) Internal air testing up to **5 psi (35 kPa)**.
 - 3) Gaps between the pipe ends up to two percent of the diameter (maximum of **1-inch (25 mm)**).

- c. The liner shall consist of a minimum thickness of **0.04 inch (1.2 mm)** of reinforced polyester resin. The outside pipe coating shall have a minimum thickness of **0.03 inches (one mm)** and shall consist of thermosetting polyester resin and sand.
- 6. Vitrified Clay Pipe: ASTM C 700.
 - a. Pipe: Vitrified clay pipe shall be manufactured from fire clay, shale, surface clay, or a combination that can meet three edge bearing strength for nominal diameters ranging from **4 inches 2000 lb/linear foot (100 mm 2980 kg/m)** to **42 inches 7000 lb/linear foot (1050 mm 10430 kg/m)**.
 - b. Joints: Joints shall be capable of supporting a shear load of **50 pounds per inch (8755 N/m)** of nominal diameter uniformly applied over an arc of not less than **120 degrees (2.09 rad)** and along a distance of **12 inches (300 mm)** adjacent to the joint. Apply an internal **10 foot (3 m) head 4.3 psi (30 kPa)** of water pressure for a period of one hour. Joints shall fully comply with **ASTM C 1208 (ASTM C 1208M)**.
- 7. Concrete: Concrete shall be **3000 psi (25 MPa)** and conform with Division 03 Section "Cast-in-place Concrete".
- 8. Bentonite: Bentonite shall conform with API SPEC 13A and have the capacity of mixing with water to form a stable and homogeneous suspension.
- 9. Backfill: Reuse excavated sand for backfill that conforms with Division 31 Section "Earth Moving".

1.3 EXECUTION

A. Preparation

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

surrounding soils or structures beyond the tolerances stated in paragraph entitled "Settlement, Alignment and Tolerances."

- i. Provide security fence around all access shaft areas and provide shaft cover(s) when the shaft area is not in use.
- j. Design of the jacking and receiving pit supports should also take into account the loading from shield or pipe jacking where appropriate, as well as special provisions and reinforcement around the breakout location. The base of the pits shall be designed to withstand uplift forces from the full design head of water, unless approved dewatering or other ground modification methods are employed.
- k. Where a thrust block is required to transfer jacking loads into the soil, it shall be properly designed and constructed by the Contractor. The backstop shall be normal (square) with the proposed pipe alignment and shall be designed to withstand the maximum jacking pressure to be used with a factor of safety of at least 2.0. It shall also be designed to minimize excessive deflections in such a manner as to avoid disturbance of adjacent structures or utilities or excessive ground movement. If a concrete thrust block or treated soil zone is utilized to transfer jacking loads into the soil, the tunnel boring is not to be jacked until the concrete or other materials have attained the required strength.
- l. Pit Backfill and Compaction: Upon completion of the pipe drive and approval of the installed pipeline by the Owner, remove all equipment, debris, and unacceptable materials from the pits and commence backfilling operation. Backfilling, compaction and pavement repairs shall be completed in accordance with Division 31 Section "Earth Moving".
- m. If tremie concrete sealing slabs are placed within the earth support system to prevent groundwater inflow when access shafts are dewatered, the sealing slabs shall be of sufficient thickness to provide a factor of safety equal to 1.2 against hydrostatic uplift in order to prevent bottom blowout when the excavation is completely dewatered.

B. Installation

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

- excavation shall be maintained at a level slightly in excess of normal hydrostatic pressure and shall be monitored continuously. The machine shall be operated so as to prevent either surface heave or loss of ground during tunneling and shall be steerable and capable of controlling the advance of the heading to maintain line and grade within the tolerances specified in paragraph entitled "Settlement, Alignment and Tolerances." The machine shall be capable of handling and removing materials of high water content from the machine head.
- 2) Each pipe casing section shall be jacked forward as the excavation progresses in such a way to provide complete and adequate, ground support at all times. A bentonite slurry (driller's mud) shall be applied to the external surface of the pipe to reduce skin friction. A jacking frame shall be provided for developing a uniform distribution of jacking forces around the periphery of the pipe. A plywood spacer shall be placed on the outer shoulder of the pipe casing joint. The thrust reaction backstop shall be properly designed and constructed.
 - 3) The backstop shall be normal (square) with the proposed pipe casing alignment and shall be designed to support the maximum obtainable jacking pressure with a safety factor at least 2.0.
 - 4) The jacking system shall be capable of continuously monitoring the jacking pressure and rate of advancement. Special care shall be taken when setting the pipe guard rails in the starter shaft to ensure correctness of the alignment, grade and stability.
- b. Using Tunneling Shields
- 1) Only tunneling equipment capable of fully supporting the face of the tunnel shall be used for pipe jacking work described.
 - 2) Tunneling equipment selected for the project shall be compatible with the geotechnical information contained in this contract. The tunneling equipment shall be capable of tunneling through mixed face conditions without exceeding the settlement tolerances specified in paragraph "Settlement, Alignment and Tolerances."
 - 3) Face pressure exerted at the heading by the tunneling machine shall be maintained as required to prevent loss of ground, groundwater inflows, and settlement or heave of the ground surface by balancing soils and groundwater pressures present.
 - 4) Dewatering for groundwater control shall be allowed at the jacking and receiving pits only.
- c. Do not jack pipe casing until the concrete thrust block and tremie seal (if selected), and grouted soil zone in starter and receiving shafts have attained the required strength.
- d. The pipe casing shall be jacked in place without damaging the pipe casing joints or completed pipe casing section.
- e. After completion of the jacking operation between starter and receiver shafts, the lubricate material shall be displaced from between the pipe casing exterior and the surrounding ground by a cement grout. Pressure and the amount of grout shall be controlled to avoid pipe damage and displacement of the pipe and soil beyond the tolerances specified in paragraph "Settlement, Alignment and Tolerances." Grouting shall be accomplished promptly after pipe installation has been completed to prevent any surface settlement due to movement of soil material into the void space or loosened zone around the pipe casing.
- f. Any pipe casing which has been damaged during installation shall be replaced by the Contractor at no additional cost. If a new replacement pipe casing is required extending from the starter to the receiver shaft, it shall be installed in conformance with the contract drawings and this section.
- g. Steel pipe casing joints shall be continuously welded with butt joint per AWS D1.1. The welds shall attain the full strength of the pipe and shall result in a full watertight section. The inner face of internal weld seam shall be flush with the pipe to facilitate the installation of the conveyance pipe in the pipe casing.
- h. Perform all welding in accordance with requirements for shielded metal arc welding of AWS D1.5 for bridges and AWS D1.1 for buildings and other structures.
- i. Fiberglass pipe casing joints shall be fully watertight and shall attain the full strength of the pipe. Casing joints shall be field connected with sleeve couplings or bell and spigot type

- joints that utilize elastomeric sealing gaskets as the sole means to maintain joint water tightness.
- j. The joint shall have the same outside diameter as the pipe so when the pipelines are assembled such that the joints are flush with the pipe inside and outside surface to facilitate installation of it conveyance pipe in the pipe casing.
 - k. All excavated material from tunnel and shaft construction shall be disposed of away from the construction site. On-site storage of material must comply with Division 01 requirements and must be stored in areas shown on site drawings or as directed. Stockpiling shall be permitted on the construction site and material shall be removed at regular intervals as directed by the Owner.
 - l. Monitor ground movements associated with the project and make suitable changes in the construction methods that control ground movements and prevent damage or detrimental movement to the work and adjacent structures and pavements.
 - m. Install instrumentation, take readings and provide the Owner with weekly reports containing measurements data with weekly reports to inspector. These actions are meant to supplement the Contractor's monitoring system and do not relieve the Contractor of its responsibility, nor place on the Owner, responsibility for control of ground movement and protection of the project and adjacent structures. Instrumentation readings shall be continued for a period of time as directed by the Owner after pipe casings have been installed to establish that detrimental settlement has not occurred.
 - n. Unprotected mining of the tunnel bore is not permitted. The tunnel face and bore shall be fully supported at all times.
 - o. A topographic survey will be performed by the Contractor before and after microtunneling and at intervals as directed by the Owner. Survey markers will be installed by the contractor at grid points located as directed by the Owner centered on the proposed tunnel alignments. Perform all remedial work including repaired if heave or settlement greater than **1 inch (25 mm)** is recorded.
 - p. Approval by the Owner of the topographic survey and final set of readings provided by the Contractor will constitute partial approval of the microtunneling phase of work.
6. Ventilation: Adequate ventilation shall be provided for all cased tunnels and shafts. Follow confined space entry procedures. Local burn permit regulations must be obeyed and complied with. The design of ventilating system shall include such factors as the volume required to furnish fresh air in the shafts, and the volume to remove dust that may be caused by the cutting of the face and other operations which may impact the laser guidance system.
 7. Lighting: Adequate lighting shall be provided for the nature of the activity being conducted by workers for the microtunneling. Both power and lighting circuits shall be separated and thoroughly insulated with ground fault interrupters are required. Lights shall comply with requirements with regards to shatter resistance and illumination requirements.
 8. Spoil Transportation: The soil transportation system shall match the excavation rate with rate of spoil removal. The system must also be capable of balancing groundwater pressures and adjustment to maintain face stability for the particular soil conditions of this project.
 9. Pipe Jacking Equipment: The main jacking equipment installed must have a capacity greater than the anticipated jacking load. Intermediate jacking stations shall be provided by the Contractor when the total anticipated jacking force needed to complete the installation may exceed the capacity of the main jacks or the designed maximum jacking force for the pipe. The jacking system shall develop a uniform distribution of jacking forces on the end of the pipe by use of thruster rings and cushioning material.
 10. Jacking Pipe: In general, pipe used for jacking shall be smooth, round, have an even outer surface, and joints that allow for easy connections between pipes. Pipe ends shall be square and smooth so that jacking loads are minimized when the pipe is jacking. Pipe used for pipe jacking shall be capable of withstanding the jacking forces that will be imposed by the process or installation, as well as the final place loading conditions. The driving ends of the pipe and intermediate joints shall be protected from damage.

- a. Any pipe showing signs of failure may be jacked through to the receiving shaft and removed. Other methods of repairing the damaged pipe may be used, as recommended by the manufacturer and subject to approval by the Owner.
 - b. The pipe manufacturer's design jacking loads shall not be exceeded during the installation process. The pipe shall be designed to take full account of all temporary installation loads.
- C. Field Quality Control
 - 1. Field Tests and Inspections: The Contractor shall perform field tests, and provide labor, equipment, and incidentals required for testing. The Contractor shall produce evidence, when required, that any item of work has been constructed in accordance with drawings and specifications.
 - 2. Testing Requirements: For pressure test, use a hydrostatic pressure 50 percent greater than the maximum working pressure of the system. Hold this pressure for not less than 2 hours. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

END OF SECTION 33 05 07 13

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Task	Specification	Specification Description
33 05 07 13	01 22 16 00	No Specification Required
33 05 07 24	33 05 07 13	Trenchless Excavation Using Microtunneling

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SECTION 33 05 63 00 - UNDERGROUND DUCTS AND UTILITY STRUCTURES

1.1 GENERAL

A. Description Of Work

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

B. Summary

1. This Section includes the following:
 - a. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs\.
 - b. Handholes and pull boxes.
 - c. Manholes.

C. Definition

1. RNC: Rigid nonmetallic conduit.

D. Submittals

1. Product Data: For the following:
 - a. Duct-bank materials, including separators and miscellaneous components.
 - b. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - c. Accessories for manholes, handholes, pull boxes, and other utility structures.
 - d. Warning tape.
 - e. Warning planks.
2. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 - a. Duct entry provisions, including locations and duct sizes.
 - b. Reinforcement details.
 - c. Frame and cover design and manhole frame support rings.
 - d. Ladder **OR** Step, **as directed**, details.
 - e. Grounding details.
 - f. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - g. Joint details.
3. Shop Drawings for Factory-Fabricated Handholes and Pull Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
 - a. Duct entry provisions, including locations and duct sizes.
 - b. Cover design.
 - c. Grounding details.
 - d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
4. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
 - a. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 - b. Drawings shall be signed and sealed by a qualified professional engineer.
5. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.
6. Qualification Data: For qualified professional engineer and testing agency.
7. Source quality-control reports
8. Field quality-control test reports.

- E. Quality Assurance
 - 1. Comply with IEEE C2.
 - 2. Comply with NFPA 70.
- F. Delivery, Storage, And Handling
 - 1. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
 - 2. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
 - 3. Lift and support precast concrete units only at designated lifting or supporting points.
- G. Project Conditions
 - 1. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - a. Notify the Owner no fewer than two days in advance of proposed interruption of electrical service.
 - b. Do not proceed with interruption of electrical service without the Owner's written permission.

1.2 PRODUCTS

- A. Conduit
 - 1. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
 - 2. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.
- B. Nonmetallic Ducts And Duct Accessories
 - 1. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.
 - 2. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type DB-60-PVC and Type DB-120-PVC, ASTM F 512, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.
 - 3. Duct Accessories:
 - a. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
 - b. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification For Electrical Systems".
 - c. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 76 mm) in size, manufactured from 6000-psi (41-MPa) concrete.
 - 1) Color: Red dye added to concrete during batching.
 - 2) Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.
- C. Precast Concrete Handholes And Pull Boxes
 - 1. Comply with ASTM C 858 for design and manufacturing processes.
 - 2. Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A153 (ASTM A153M) and ASTM A123 (ASTM A123M).
 - 3. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or pull box.

- a. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
- b. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
- c. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
 - 1) Cover Hinges: Concealed, with hold-open ratchet assembly.
 - 2) Cover Handle: Recessed.
- d. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing stainless-steel bolts.
 - 1) Cover Hinges: Concealed, with hold-open ratchet assembly.
 - 2) Cover Handle: Recessed.
- e. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- f. Cover Legend: Molded lettering, "ELECTRIC" **OR** "TELEPHONE" **OR** As indicated for each service, **as directed**.
- g. Configuration: Units shall be designed for flush burial and have open **OR** closed **OR** integral closed, **as directed**, bottom, unless otherwise indicated.
- h. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - 1) Extension shall provide increased depth of **12 inches (300 mm)**.
 - 2) Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
- i. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional **12 inches (300 mm)** vertically and horizontally to accommodate alignment variations.
 - 1) Windows shall be located no less than **6 inches (150 mm)** from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - 2) Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - 3) Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
- j. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - 1) Type and size shall match fittings to duct or conduit to be terminated.
 - 2) Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
- k. Handholes **12 inches wide by 24 inches long (300 mm wide by 600 mm long)** and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

D. Handholes and Pull Boxes Other Than Precast Concrete

1. Description: Comply with SCTE 77.
 - a. Color: Gray **OR** Green, **as directed**.
 - b. Configuration: Units shall be designed for flush burial and have open **OR** closed **OR** integral closed, **as directed**, bottom, unless otherwise indicated.
 - c. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 - d. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - e. Cover Legend: Molded lettering, "ELECTRIC" **OR** "TELEPHONE" **OR** As indicated for each service, **as directed**.
 - f. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
 - g. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 - h. Handholes **12 inches wide by 24 inches long (300 mm wide by 600 mm long)** and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2. Polymer Concrete Handholes and Pull Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
3. Fiberglass Handholes and Pull 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 Pull Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete **OR** reinforced concrete **OR** cast iron **OR** hot-dip galvanized-steel diamond plate **OR** fiberglass, **as directed**.
5. High-Density Plastic Pull Boxes: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover shall be polymer concrete **OR** hot-dip galvanized-steel diamond plate **OR** plastic, **as directed**.

E. Precast Manholes

1. Comply with ASTM C 858, with structural design loading as specified in Para. 1.3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.
 - a. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional **12 inches (300 mm)** vertically and horizontally to accommodate alignment variations.
 - 1) Windows shall be located no less than **6 inches (150 mm)** from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 - 2) Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - 3) Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 - b. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - 1) Type and size shall match fittings to duct or conduit to be terminated.
 - 2) Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.
2. Concrete Knockout Panels: **1-1/2 to 2 inches (38 to 50 mm)** thick, for future conduit entrance and sleeve for ground rod.
3. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

F. Cast-In-Place Manholes

1. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.
2. Materials: Comply with ASTM C 858 and with Division 03 Section "Cast-in-place Concrete".
 - a. Concrete shall have a minimum compressive strength of **3000 psi (20 MPa)**.
3. Structural Design Loading: As specified in "Underground Enclosure Application" Article.

G. Utility Structure Accessories

1. Ferrous metal hardware, where indicated, shall be hot-dip galvanized complying with ASTM **A 153 (A 153M)** and **A 123 (A 123M)**.
2. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
 - a. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B **OR** cast aluminum, **as directed**, with milled cover-to-frame bearing surfaces; diameter, **26 inches (660 mm) OR 29 inches (737 mm)**, **as directed**.
 - 1) Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

- 2) Special Covers: Recess in face of cover designed to accept finish material in paved areas.
- b. Cover Legend: Cast in. Selected to suit system.
 - 1) Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
 - 2) Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
 - 3) Legend: "SIGNAL" for communications, data, and telephone duct systems.
- c. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - 1) Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.
3. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
4. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.
 - a. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.
5. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- (32-mm-) diameter eye, rated 2500-lbf (11-kN) minimum tension.
6. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
 - a. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.
7. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (32 mm) minimum at base.
 - a. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.
8. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.
9. Cable Rack Assembly: Steel, hot-rolled **OR** hot-dip, **as directed**, galvanized, except insulators.
 - a. Stanchions: T-section or channel; 2-1/4-inch (57-mm) nominal size; punched with 14 holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.
 - b. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 18 inches (460 mm) with 250-lb (114-kg) minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
 - c. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
10. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
 - a. Stanchions: Nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with minimum of 9 holes for arm attachment.
 - b. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 20 inches (508 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties.
11. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
12. Fixed Manhole Ladders: Arranged for attachment to roof or wall **OR** and floor, **as directed**, of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin **OR** hot-dip galvanized steel, **as directed**.

13. Portable Manhole Ladders: UL-listed, heavy-duty wood **OR** fiberglass, **as directed**, specifically designed for portable use for access to electrical manholes. Minimum length equal to distance from deepest manhole floor to grade plus **36 inches (900 mm)**. One required.
14. Cover Hooks: Heavy duty, designed for lifts **60 lbf (270 N)** and greater **OR** Light duty, designed for lifts less than **60 lbf (270 N)**, **as directed**. Two required.

H. Source Quality Control

1. Test and inspect precast concrete utility structures according to ASTM C 1037.
2. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and pull boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - a. Engage a qualified testing agency to evaluate nonconcrete handholes and pull boxes.
 - b. 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. Corrosion Protection

1. Aluminum shall not be installed in contact with earth or concrete.

B. Underground Duct Application

1. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-80 **OR** EPC-40 **OR** EB-20, **as directed**, -PVC, in concrete-encased duct bank, unless otherwise indicated.
2. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80 **OR** EPC-40 **OR** EB-20, **as directed**, -PVC, in concrete-encased duct bank, unless otherwise indicated.
3. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80 **OR** EPC-40 **as directed**, -PVC, in direct-buried duct bank, unless otherwise indicated.
4. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-80 **OR** EPC-40, **as directed**, -PVC, in direct-buried duct bank, unless otherwise indicated.
5. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40 **OR** EB-20, **as directed**, -PVC, in concrete-encased duct bank, unless otherwise indicated.
6. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC **OR** Underground plastic utilities duct, NEMA Type DB-60-PVC **OR** Underground plastic utilities duct, NEMA Type DB-120-PVC, **as directed**, installed in direct-buried **OR** concrete-encased, **as directed**, duct bank, unless otherwise indicated.
7. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40 **OR** DB-60 **OR** DB-120, **as directed**, -PVC, in direct-buried duct bank, unless otherwise indicated.
8. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EB-20-PVC, in concrete-encased duct bank, unless otherwise indicated.
9. Underground Ducts Crossing Paved Paths **OR** Walks and Driveways **OR** Roadways and Railroads, **as directed**: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

C. Underground Enclosure Application

1. Handholes and Pull Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
 - a. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, H-10 **OR** H-20, **as directed**, structural load rating.
 - b. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 **OR** Polymer concrete, SCTE 77, Tier 15 **OR** Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15 **OR** Fiberglass-reinforced polyester resin, SCTE 77, Tier 15 **OR** High-density plastic, SCTE 77, Tier 15, **as directed**, structural load rating.

- c. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 **OR** Polymer concrete units, SCTE 77, Tier 8 **OR** Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 **OR** High-density plastic, SCTE 77, Tier 8, **as directed**, structural load rating.
 - d. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin **OR** High-density plastic, **as directed**, structurally tested according to SCTE 77 with **3000-lbf (13 345-N)** vertical loading.
 2. Manholes: Precast or cast-in-place concrete.
 - a. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
 - b. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.
- D. Earthwork
 1. Excavation and Backfill: Comply with Division 31 Section "Earth Moving", but do not use heavy-duty, hydraulic-operated, compaction equipment.
 2. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
 3. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Section(s) "Turf And Grasses" AND "Plants".
 4. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting And Patching".
- E. Duct Installation
 1. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
 2. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of **48 inches (1220 mm) OR 12.5 feet (4 m) OR 25 feet (7.5 m)**, **as directed**, both horizontally and vertically, at other locations, unless otherwise indicated.
 3. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
 4. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately **10 inches (250 mm)** o.c. for **5-inch (125-mm)** ducts, and vary proportionately for other duct sizes.
 - a. Begin change from regular spacing to end-bell spacing **10 feet (3 m)** from the end bell without reducing duct line slope and without forming a trap in the line.
 - b. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
 - c. Grout end bells into structure walls from both sides to provide watertight entrances.
 5. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least **10 feet (3 m)** outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results For Electrical".
 6. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least **15-psig (1.03-MPa)** hydrostatic pressure.
 7. Pulling Cord: Install **100-lbf- (445-N-)** test nylon cord in ducts, including spares.
 8. Concrete-Encased Ducts: Support ducts on duct separators.
 - a. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than **4 OR 5, as directed**, spacers per **20 feet (6 m)** of duct. Secure

- separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately **6 inches (150 mm)** between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
- b. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - 1) Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - 2) If more than one pour is necessary, terminate each pour in a vertical plane and install **3/4-inch (19-mm)** reinforcing rod dowels extending **18 inches (450 mm)** into concrete on both sides of joint near corners of envelope.
 - c. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
 - d. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 - e. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 - f. Minimum Space between Ducts: **3 inches (75 mm)** between ducts and exterior envelope wall, **2 inches (50 mm)** between ducts for like services, and **4 inches (100 mm)** between power and signal ducts.
 - g. Depth: Install top of duct bank at least **24 inches (600 mm)** below finished grade in areas not subject to deliberate traffic, and at least **30 inches (750 mm)** below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
 - h. Stub-Ups:
 - 1) Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
OR
 Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a) Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with **3 inches (75 mm)** of concrete.
 - b) Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of **60 inches (1500 mm)** from edge of base. Install insulated grounding bushings on terminations at equipment.
 - i. Warning Tape: Bury warning tape approximately **12 inches (300 mm)** above all concrete-encased ducts and duct banks. Align tape parallel to and within **3 inches (75 mm)** of the centerline of duct bank. Provide an additional warning tape for each **12-inch (300-mm)** increment of duct-bank width over a nominal **18 inches (450 mm)**. Space additional tapes **12 inches (300 mm)** apart, horizontally.
9. Direct-Buried Duct Banks:
- a. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 - b. Space separators close enough to prevent sagging and deforming of ducts, with not less than **4 OR 5, as directed**, spacers per **20 feet (6 m)** of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement

due to expansion and contraction as temperature changes. Stagger spacers approximately **6 inches (150 mm)** between tiers.

- c. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than **6 inches (150 mm)** in nominal diameter.
- d. Install backfill as specified in Division 31 Section "Earth Moving".
- e. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to **4 inches (100 mm)** over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving".
- f. Install ducts with a minimum of **3 inches (75 mm)** between ducts for like services and **6 inches (150 mm)** between power and signal ducts.
- g. Depth: Install top of duct bank at least **36 inches (900 mm)** below finished grade, unless otherwise indicated.
- h. Set elevation of bottom of duct bank below the frost line.
- i. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.

OR

Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

- 1) Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with **3 inches (75 mm)** of concrete.
- 2) For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of **60 inches (1500 mm)** from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
- j. Warning Planks: Bury warning planks approximately **12 inches (300 mm)** above direct-buried ducts and duct banks, placing them **24 inches (600 mm)** o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each **12-inch (300-mm)** increment of duct-bank width over a nominal **18 inches (450 mm)**. Space additional planks **12 inches (300 mm)** apart, horizontally.

F. Installation Of Concrete Manholes, Handholes, And Pull Boxes

1. Cast-in-Place Manhole Installation:
 - a. Finish interior surfaces with a smooth-troweled finish.
 - b. Windows for Future Duct Connections: Form and pour concrete knockout panels **1-1/2 to 2 inches (38 to 50 mm)** thick, arranged as indicated.
 - c. Cast-in-place concrete, formwork, and reinforcement are specified in Division 03 Section "Cast-in-place Concrete".
2. Precast Concrete Handhole and Manhole Installation:
 - a. Comply with ASTM C 891, unless otherwise indicated.
 - b. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 - c. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from **1-inch (25-mm)** sieve to **No. 4 (4.75-mm)** sieve and compacted to same density as adjacent undisturbed earth.
3. Elevations:
 - a. Manhole Roof: Install with rooftop at least **15 inches (380 mm)** below finished grade.
 - b. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames **1 inch (25 mm)** above finished grade.
 - c. Install handholes with bottom below the frost line, below grade.

- d. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes **1 inch (25 mm)** above finished grade.
 - e. Where indicated, cast handhole cover frame integrally with handhole structure.
 4. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
 5. Manhole Access: Circular opening in manhole roof; sized to match cover size.
 - a. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 - b. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
 6. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section(s) "Elastomeric Sheet Waterproofing" OR "Thermoplastic Sheet Waterproofing", **as directed**. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
 7. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing". After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
 8. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
 9. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
 10. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than **3-7/8 inches (98 mm)** for manholes and **2 inches (50 mm)** for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
 11. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.
- G. Installation Of Handholes And Pull Boxes Other Than Precast Concrete
1. Install handholes and pull boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
 2. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from **1/2-inch (12.7-mm)** sieve to **No. 4 (4.75-mm)** sieve and compacted to same density as adjacent undisturbed earth.
 3. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes **1 inch (25 mm)** above finished grade.
 4. Install handholes and pull boxes with bottom below the frost line, below grade.
 5. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
 6. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
 7. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 - a. Concrete: **3000 psi (20 kPa)**, 28-day strength, complying with Division 03 Section "Cast-in-place Concrete", with a troweled finish.

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- b. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).
- H. Grounding
- 1. Ground underground ducts and utility structures according to Division 26 Section "Grounding And Bonding For Electrical Systems".
- I. Field Quality Control
- 1. Perform the following tests and inspections:
 - a. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - b. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 - c. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding And Bonding For Electrical Systems".
 - 2. Correct deficiencies and retest as specified above to demonstrate compliance.
 - 3. Prepare test and inspection reports.
- J. Cleaning
- 1. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
 - 2. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 33 05 63 00

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Task	Specification(s)
01 22 16 00	01 22 16 00
01 22 20 00	01 22 16 00
01 22 23 00	01 22 16 00
01 52 13 00	01 52 13 00, 01 22 16 00
01 53 16 00	01 22 16 00
01 54 23 00	01 54 23 00, 01 54 23 00a, 01 22 16 00
01 55 26 00	01 22 16 00
01 56 26 00	01 22 16 00
01 56 29 00	01 22 16 00
01 56 39 00	01 22 16 00
01 66 19 00	01 22 16 00
01 74 19 00	01 74 19 00, 01 22 16 00
02 41 13 13	02 41 13 13, 02 41 13 13a
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