



Building knowledge

# Job Order Contract Technical Specifications

Book 1 CSI Divisions 01 - 31 June 2018

County of San Mateo,  
Electrical and Lighting



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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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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
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 32 33 00 - SCHEDULE OF VALUES

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the preparation, content and submittal of the schedule of values. The Schedule of Values is an itemized list that establishes the value or cost of each part of the Work. It shall be used as the basis for preparing progress payments.

#### B. Preparation

1. Schedule shall show breakdown of labor, materials equipment and other costs as directed by the Owner.
2. Costs shall be in sufficient detail to indicate separate amounts for each major subsection of the Work. The Contractor may include an item for bond, insurance, temporary facilities and job mobilization.
3. Schedule of Values shall be prepared on 8-1/2-inch by 11-inch white paper.
4. Use the major subsections of the Detailed Scope of Work as the basis for Schedule format. List sub-items of major products or systems as appropriate or when requested by the Owner.
5. When requested by the Owner, support values with data that will substantiate their correctness.
6. The sum of the individual values shown on the Schedule of Values must equal the total Job Order Price.
7. Schedule shall show the purchase and delivery costs for materials and equipment that the Contractor anticipates it shall request payment for prior to their installation.

- #### C. Submittal: Submit two copies of Schedule, or any other number of copies as directed by the Owner, to the Owner for approval at least 20 days prior to submitting first application for a progress payment. After review by the Owner, revise and resubmit Schedule as required until it is approved.

### 1.2 PRODUCTS (Not Used)

### 1.3 EXECUTION (Not Used)

END OF SECTION 01 32 33 00



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**SECTION 01 32 33 00a - SPECIAL PROCEDURES FOR HISTORIC TREATMENT**

## 1.1 GENERAL

## A. Summary

1. This Section includes special procedures for historic treatment on Project including, but not limited to, the following:
  - a. Storage and protection of existing historic materials.
  - b. Temporary protection of historic materials during construction.
  - c. Protection during application of chemicals.
  - d. Protection during use of heat-generating equipment.
  - e. Historic treatment procedures.
  - f. Removal of bird excrement.
2. This specification applies to all tasks in the Construction Task Catalog® when they are used on Historic Buildings or Historic Sites.

## B. Definitions

1. "Preservation": To apply measures necessary to sustain the existing form, integrity, and materials of a historic property. Work may include preliminary measures to protect and stabilize the property.
2. "Rehabilitation": To make possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features that convey its historical, cultural, or architectural values.
3. "Restoration": To accurately depict the form, features, and character of a property as it appeared at a particular period of time by means of the removal of features from other periods in its history and the reconstruction of missing features from the restoration period.
4. "Reconstruction": To reproduce in the exact form and detail a building, structure, or artifact as it appeared at a specific period in time.
5. "Stabilize": To apply measures designed to reestablish a weather-resistant enclosure and the structural reinforcement of an item or portion of the building while maintaining the essential form as it exists at present.
6. "Protect and Maintain": To remove deteriorating corrosion, reapply protective coatings, and install protective measures such as temporary guards; to provide the least degree of intervention.
7. "Repair": To stabilize, consolidate, or conserve; to retain existing materials and features while employing as little new material as possible. Repair includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials. Within restoration, repair also includes limited replacement in kind, rehabilitation, and reconstruction, with compatible substitute materials for deteriorated or missing parts of features when there are surviving prototypes.
8. "Replace": To duplicate and replace entire features with new material in kind. Replacement includes the following conditions:
  - a. Duplication: Includes replacing elements damaged beyond repair or missing. Original material is indicated as the pattern for creating new duplicated elements.
  - b. Replacement with New Materials: Includes replacement with new material when original material is not available as patterns for creating new duplicated elements.
  - c. Replacement with Substitute Materials: Includes replacement with compatible substitute materials. Substitute materials are not allowed, unless otherwise indicated.
9. "Remove": To detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
10. "Remove and Salvage": To detach items from existing construction and deliver them to the Owner ready for reuse.
11. "Remove and Reinstall": To detach items from existing construction, repair and clean them for reuse, and reinstall them where indicated.
12. "Existing to Remain" or "Retain": Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled.



13. "Material in Kind": Material that matches existing materials, as much as possible, in species, cut, color, grain, and finish.

C. Submittals

1. Historic Treatment Program: Submit a written plan for each phase or process including protection of surrounding materials during operations. Describe in detail materials, methods, and equipment to be used for each phase of work.
2. Alternative Methods and Materials: If alternative methods and materials to those indicated are proposed for any phase of work, provide a written description including evidence of successful use on other, comparable projects, and program of testing to demonstrate effectiveness for use on this Project.
3. Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by historic treatment operations. Submit before work begins.

D. Quality Assurance

1. Historic Treatment Specialist Qualifications: A firm that employs personnel, including supervisory personnel, experienced and skilled in the processes and operations indicated.
2. Historic Treatment Preconstruction Conference: Conduct conference at Project site.

E. Storage And Protection Of Historic Materials

1. Removed and Salvaged Historic Materials:
  - a. Clean salvaged historic 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.
  - f. Do not dispose of items removed from existing construction without prior written consent of the Owner.
2. Removed and Reinstalled Historic Materials:
  - a. Clean and repair historic items to functional condition adequate for intended reuse.
  - 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.
3. Existing Historic Materials to Remain: Protect construction indicated to remain against damage and soiling during historic treatment. When permitted, items may be removed to a suitable, protected storage location during historic treatment and cleaned and reinstalled in their original locations after historic treatment operations are complete.
4. Storage and Protection: When removed from their existing location, store historic materials within a weathertight enclosure where they are protected from wetting by rain, snow, or ground water, and temperature variations. Secure stored materials to protect from theft.
  - a. Identify removed items with an inconspicuous mark indicating their original location.

F. Project-Site Conditions

1. Exterior Cleaning and Repairing:
  - a. Proceed with the work only when forecasted weather conditions are favorable.
    - 1) Wet Weather: Do not attempt repairs during rainy or foggy weather. Do not apply primer, paint, putty, or epoxy when the relative humidity is above 80 percent. Do not remove exterior elements of structures when rain is forecast or in progress.
    - 2) Do not perform exterior wet work when the air temperature is below 40 deg F (5 deg C).



- 3) Do not begin cleaning, patching, or repairing when there is any likelihood of frost or freezing.
  - 4) Do not begin cleaning when either the air or the surface temperature is below 45 deg F (7 deg C) unless approved means are provided for maintaining a 45 deg F (7 deg C) temperature of the air and materials during, and for 48 hours subsequent to, cleaning.
    - b. Perform cleaning and rinsing of the exterior only during daylight hours.
2. the Owner will occupy portions of building immediately adjacent to historic treatment area. Conduct historic treatment so the Owner's operations will not be disrupted. Provide not less than 72 hours' notice to the Owner of activities that will affect the Owner's operations.

## 1.2 PRODUCTS (Not Used)

## 1.3 EXECUTION

### A. Protection, General

1. Comply with manufacturer's written instructions for precautions and effects of products and procedures on adjacent building materials, components, and vegetation.
2. Ensure that supervisory personnel are present when work begins and during its progress.
3. Temporary Protection of Historic Materials during Construction:
  - a. Protect existing materials during installation of temporary protections and construction. Do not deface or remove existing materials.
  - b. Attachments of temporary protection to existing construction shall be approved prior to installation.
4. Protect landscape work adjacent to or within work areas as follows:
  - a. Provide barriers to protect tree trunks.
  - b. Bind spreading shrubs.
  - c. Use coverings that allow plants to breathe and remove coverings at the end of each day. Do not cover plant material with a waterproof membrane for more than 8 hours at a time.
  - d. Set scaffolding and ladder legs away from plants.
5. Existing Drains: Prior to the start of work or any cleaning operations, test drains and other water removal systems to ensure that drains and systems are functioning properly. Notify the Owner immediately of drains or systems that are stopped or blocked. Do not begin Work of this Section until the drains are in working order.
  - a. Provide a method to prevent solids including stone or mortar residue from entering the drains or drain lines. Clean out drains and drain lines that become blocked or filled by sand or any other solids because of work performed under this Contract.
  - b. Protect storm drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.

### B. Protection During Application Of Chemicals

1. Protect persons, motor vehicles, surrounding surfaces of building being restored, building site, plants, and surrounding buildings from harm or damage resulting from applications of chemical cleaners and paint removers.
2. Comply with requirements in Division 01 Section "Temporary Facilities And Controls".
3. Cover adjacent surfaces with materials that are proven to resist chemical cleaners selected for Project unless chemicals being used will not damage adjacent surfaces. Use covering materials that contain only waterproof, UV-resistant adhesives. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
4. Do not clean surfaces during winds of sufficient force to spread cleaning solutions to unprotected surfaces.
5. Neutralize and collect alkaline and acid wastes and dispose of off the Owner's property.



6. Dispose of runoff from chemical operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

C. Protection During Use Of Heat-Generating Equipment

1. Comply with the following procedures while performing work with heat-generating equipment, including welding, cutting, soldering, brazing, paint removal with heat, and other operations where open flames or implements utilizing heat are used:
  - a. Obtain the Owner's approval for operations involving use of open-flame or welding equipment.
    - 1) Notification shall be given for each occurrence and location of work with heat-generating equipment.
  - b. As far as practical, use heat-generating equipment in shop areas or outside the building.
  - c. Before work with heat-generating equipment commences, furnish personnel to serve as a fire watch (or watches) for location(s) where work is to be performed.
  - d. Do not perform work with heat-generating equipment in or near rooms or in areas where flammable liquids or explosive vapors are present or thought to be present. Use a combustible gas indicator test to ensure that the area is safe.
  - e. Remove and keep the area free of combustibles, including, rubbish, paper, waste, etc., within area of operations.
    - 1) If combustible material cannot be removed, provide fireproof blankets to cover such materials.
  - f. Where possible, furnish and use baffles of metal or gypsum board to prevent the spraying of sparks or hot slag into surrounding combustible material.
  - g. Prevent the extension of sparks and particles of hot metal through open windows, doors, holes, and cracks in floors, walls, ceilings, roofs, and other openings.
  - h. Inspect each location of the day's work not sooner than 30 minutes after completion of operations to detect hidden or smoldering fires and to ensure that proper housekeeping is maintained.
2. Where sprinkler protection exists and is functional, maintain it without interruption while operations are being performed. If operations are performed close to automatic sprinkler heads, shield the individual heads temporarily with guards.

D. Historic Treatment Procedures

1. The principal aim of preservation work is to halt the process of deterioration and stabilize the item's condition, unless otherwise indicated. Repair is required where specifically indicated. The following procedures shall be followed:
  - a. Retain as much existing material as possible; repair and consolidate rather than replace.
  - b. Use additional material or structure to reinforce, strengthen, prop, tie, and support existing material or structure.
  - c. Use reversible processes wherever possible.
  - d. Use traditional replacement materials and techniques. New work shall be distinguishable to the trained eye, on close inspection, from old work.
  - e. Record the work before the procedure with preconstruction photos and during the work with periodic construction photos.
2. Prohibit smoking by personnel performing work on or near historic structures.
3. Obtain review and written approval in the form of a Constructive Change Directive or Supplemental Instruction before making changes or additions to construction or removing historic materials.
4. Notify the Owner of visible changes in the integrity of material or components whether due to environmental causes including biological attack, UV degradation, freezing, or thawing; or due to structural defects including cracks, movement, or distortion.
  - a. Do not proceed with the work in question until directed.



5. Where missing features are indicated to be repaired or replaced, provide features whose designs are based on accurate duplications rather than on conjectural designs, subject to the approval of the Owner and Historic Treatment Specialist.
  6. Where Work requires existing features to be removed, cleaned, and reused, perform these operations without damage to the material itself, to adjacent materials, or to the substrate.
  7. Identify new or replacement materials and features with inconspicuous, permanent marks to distinguish them from original materials. Record the legend of identification marks and the locations of these marks on Record Drawings.
  8. When cleaning, match samples of existing materials that have been cleaned and identified for acceptable cleaning levels. Avoid overcleaning to prevent damage to existing materials during cleaning.
- E. Removal Of Bird Excrement
1. General: Before disturbing accumulated bird excrement, consult with an occupational medicine physician, industrial hygienist, and authorities having jurisdiction to determine acceptable removal procedures and appropriate protective measures for personnel.
  2. Removing Bird Excrement: Treat bird excrement before its removal as required by authorities having jurisdiction.
    - a. Prior to removal, dampen excrement to prevent it from becoming airborne.
    - b. Use only nonmetallic tools (plastic spatulas and brushes with natural fiber or nylon bristles, or their equivalent) to remove excrement.
    - c. Collect removed excrement and legally disposed of off site.
    - d. Perform bird excrement removal work from the outside of the building with windows and other openings in the building closed.

END OF SECTION 01 32 33 00a



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## SECTION 01 32 33 00b - LEED REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes general requirements and procedures for compliance with certain USGBC LEED prerequisites and credits needed for Project to obtain LEED-Certified **OR** Silver **OR** Gold **OR** Platinum, **as directed**, certification based on USGBC's "LEED 2009 for New Construction & Major Renovations," "LEED 2009 for Commercial Interiors," "LEED 2009 for Core and Shell Development," or "LEED 2009 for Schools New Construction and Major Renovations."
1. Other LEED prerequisites and credits needed to obtain LEED certification depend on product selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.
  2. Additional LEED prerequisites and credits needed to obtain the indicated LEED certification depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.
  3. A copy of the LEED Project checklist is attached at the end of this Section for information only.
  4. Specific requirements for LEED are included in greater detail in other Sections.

#### 1.2 DEFINITIONS

- A. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Certificates shall include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
- B. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value. Manufacturing refers to the final assembly of components into the building product that is installed at Project site.
- C. Recycled Content: The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.
1. "Post-consumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
  2. "Pre-consumer" material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

#### 1.3 ADMINISTRATIVE REQUIREMENTS

- A. Respond to questions and requests from the Owner and the USGBC regarding LEED credits that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend



on Contractor's procedures until the USGBC has made its determination on the project's LEED certification application. Document responses as informational submittals.

#### 1.4 ACTION SUBMITTALS

- A. General: Submit additional LEED submittals required by other Specification Sections.
- B. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
- C. LEED Documentation Submittals:
  - 1. FOR CONSTRUCTION AND MAJOR RENOVATIONS:
    - a. Credit EA 5: Product data and wiring diagrams for sensors and data collection system used to provide continuous metering of building energy-consumption performance over time **OR** a period of time of not less than one year of postconstruction occupancy, **as directed**.
    - b. Credit MR 2: Comply with Section 017419 "Construction Waste Management and Disposal."
    - c. Credit MR 3: Receipts for salvaged and refurbished materials used for Project, indicating sources and costs for salvaged and refurbished materials.
    - d. Credit MR 4: Product data and certification letter from product manufacturers indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating material cost for each product having recycled content.
    - e. Credit MR 5: Product data for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
    - f. Credit MR 7: Product data and chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.
    - g. Credit IEQ 3.1:
      - 1) Construction indoor-air-quality management plan.
      - 2) Product data for temporary filtration media.
      - 3) Product data for filtration media used during occupancy.
      - 4) Construction Documentation: Six photographs at three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the indoor-air-quality management measures, such as protection of ducts and on-site stored or installed absorptive materials.
    - h. Credit IEQ 3.2:
      - 1) Signed statement describing the building air flush-out procedures including the dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.
      - 2) Product data for filtration media used during flush-out and during occupancy.
      - 3) Report from testing and inspecting agency indicating results of indoor-air-quality testing and documentation showing compliance with indoor-air-quality testing procedures and requirements.
    - i. Credit IEQ 4.1: Product data for adhesives and sealants used inside the weatherproofing system indicating VOC content of each product used.
    - j. Credit IEQ 4.2: Product data for paints and coatings used inside the weatherproofing system indicating VOC content of each product used.
    - k. Credit IEQ 4.4: Product data for products containing composite wood or agrifiber products or wood glues indicating that they do not contain urea-formaldehyde resin.
  - 2. FOR COMMERCIAL INTERIORS:



- a. Credit EA 3: Product data and wiring diagrams for sensors and data collection system used to provide continuous metering of building energy-consumption performance over time **OR** a period of time of not less than one year of postconstruction occupancy, **as directed**.
  - b. Credit MR 2: Comply with Section 017419 "Construction Waste Management and Disposal."
  - c. Credit MR 3.1 and Credit MR 3.2: Receipts for salvaged and refurbished materials used for Project, indicating sources and costs for salvaged and refurbished materials.
  - d. Credit MR 4: Product data and certification letter from product manufacturers indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating material costs for each product having recycled content.
  - e. Credit MR 5: Product data indicating location of material manufacturer for regionally manufactured materials. Include statement indicating cost for each regionally manufactured material and for each regionally extracted and manufactured material.
    - 1) Include statement indicating distance from manufacturer to Project for each regionally manufactured material.
    - 2) Include statement indicating location of and distance from Project to point of extraction, harvest, or recovery for each raw material used in regionally extracted and manufactured materials.
  - f. Credit MR 7: Product data and chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.
  - g. Credit IEQ 3.1:
    - 1) Construction indoor-air-quality management plan.
    - 2) Product data for temporary filtration media.
    - 3) Product data for filtration media used during occupancy.
    - 4) Construction Documentation: Six photographs at three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the indoor-air-quality management measures, such as protection of ducts and on-site stored or installed absorptive materials.
  - h. Credit IEQ 3.2:
    - 1) Signed statement describing the building air flush-out procedures including the dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.
    - 2) Product data for filtration media used during flush-out and during occupancy.
    - 3) Report from testing and inspecting agency indicating results of indoor-air-quality testing and documentation showing compliance with indoor-air-quality testing procedures and requirements.
  - i. Credit IEQ 4.1: Product data for adhesives and sealants used inside the weatherproofing system indicating VOC content of each product used.
  - j. Credit IEQ 4.2: Product data for paints and coatings used inside the weatherproofing system indicating VOC content of each product used.
  - k. Credit IEQ 4.4: Product data for products containing composite wood or agrifiber products or wood glues indicating that they do not contain urea-formaldehyde resin.
3. FOR CORE AND SHELL DEVELOPMENT:
- a. Credit EA 5.1 and 5.2: Product data and wiring diagrams for sensors and data collection system used to provide continuous metering of building energy-consumption performance over time **OR** a period of time of not less than one year of postconstruction occupancy, **as directed**.
  - b. Credit MR 2: Comply with Section 017419 "Construction Waste Management and Disposal."
  - c. Credit MR 3: Receipts for salvaged and refurbished materials used for Project, indicating sources and costs for salvaged and refurbished materials.
  - d. Credit MR 4: Product data and certification letter from product manufacturers indicating percentages by weight of post-consumer and pre-consumer recycled content for products



- having recycled content. Include statement indicating material costs for each product having recycled content.
- e. Credit MR 5: Product data for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
  - f. Credit MR 6: Product data and chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.
  - g. Credit IEQ 3:
    - 1) Construction indoor-air-quality management plan.
    - 2) Product data for temporary filtration media.
    - 3) Product data for filtration media used during occupancy.
    - 4) Construction Documentation: Six photographs at three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the indoor-air-quality management measures, such as protection of ducts and on-site stored or installed absorptive materials.
  - h. Credit IEQ 4.1: Product data for adhesives and sealants used inside the weatherproofing system indicating VOC content of each product used.
  - i. Credit IEQ 4.2: Product data for paints and coatings used inside the weatherproofing system indicating VOC content of each product used.
  - j. Credit IEQ 4.4: Product data for products containing composite wood or agrifiber products or wood glues indicating that they do not contain urea-formaldehyde resin.
4. FOR SCHOOLS:
- a. Credit EA 5: Product data and wiring diagrams for sensors and data collection system used to provide continuous metering of building energy-consumption performance over time **OR** a period of time of not less than one year of postconstruction occupancy, **as directed**.
  - b. Credit MR 2: Comply with Section 017419 "Construction Waste Management and Disposal."
  - c. Credit MR 3: Receipts for salvaged and refurbished materials used for Project, indicating sources and costs for salvaged and refurbished materials.
  - d. Credit MR 4: Product data and certification letter from product manufacturers indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating material costs for each product having recycled content.
  - e. Credit MR 5: Product data for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
  - f. Credit MR 7: Product data and chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.
  - g. Credit IEQ 3.1:
    - 1) Construction indoor-air-quality management plan.
    - 2) Product data for temporary filtration media.
    - 3) Product data for filtration media used during occupancy.
    - 4) Construction Documentation: Six photographs at three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the indoor-air-quality management measures, such as protection of ducts and on-site stored or installed absorptive materials.
  - h. Credit IEQ 3.2:
    - 1) Signed statement describing the building air flush-out procedures including the dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.
    - 2) Product data for filtration media used during flush-out and during occupancy.



- 3) Report from testing and inspecting agency indicating results of indoor-air-quality testing and documentation showing compliance with indoor-air-quality testing procedures and requirements.
- i. Credit IEQ 4: Laboratory test reports for the following products and systems installed inside the weatherproofing system indicating that they meet the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
  - 1) Adhesives and sealants.
  - 2) Paints and coatings.
  - 3) Composite wood and agrifiber products.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For LEED coordinator.
- B. Project Materials Cost Data: Provide statement indicating total cost for materials used for Project. Costs exclude labor, overhead, and profit. Include breakout of costs for the following categories of items:
  1. Furniture.
  2. Plumbing.
  3. Mechanical.
  4. Electrical.
  5. Specialty items such as elevators and equipment.
  6. Wood-based construction materials.
- C. LEED Action Plans: Provide preliminary submittals within seven **OR 14 OR 30 OR 60, as directed**, days of date established for commencement of the Work **OR** the Notice to Proceed **OR** the Notice of Award, **as directed**, indicating how the following requirements will be met:
  1. FOR CONSTRUCTION AND MAJOR RENOVATIONS:
    - a. Credit MR 2: Waste management plan complying with Section 017419 "Construction Waste Management and Disposal."
    - b. Credit MR 3: List of proposed salvaged, refurbished, and reused materials. Identify each material that will be salvaged, refurbished, or reused, including its source, cost, and replacement cost if the item was to be purchased new.
    - c. Credit MR 4: List of proposed materials with recycled content. Indicate cost, post-consumer recycled content, and pre-consumer recycled content for each product having recycled content.
    - d. Credit MR 5: List of proposed regional materials. Identify each regional material, including its source, cost, and the fraction by weight that is considered regional.
    - e. Credit MR 7: List of proposed certified wood products. Indicate each product containing certified wood, including its source and cost of certified wood products.
    - f. Credit IEQ 3.1: Construction indoor-air-quality management plan.
  2. FOR COMMERCIAL INTERIORS:
    - a. Credit MR 2: Waste management plan complying with Section 017419 "Construction Waste Management and Disposal."
    - b. Credit MR 3.1 and Credit MR 3.2: List of proposed salvaged, refurbished, and reused materials. Identify each material that will be salvaged, refurbished, or reused, including its source, cost, and replacement cost if the item was to be purchased new.
    - c. Credit MR 4: List of proposed materials with recycled content. Indicate cost, post-consumer recycled content, and pre-consumer recycled content for each product having recycled content.
    - d. Credit MR 5: List of proposed regionally manufactured materials and regionally extracted and manufactured materials.
      - 1) Identify each regionally manufactured material, including its source and cost.



- 2) Identify each regionally extracted and manufactured material, including its source and cost.
  - e. Credit MR 7: List of proposed certified wood products. Indicate each product containing certified wood, including its source and cost of certified wood products.
  - f. Credit IEQ 3.1: Construction indoor-air-quality management plan.
  3. FOR CORE AND SHELL DEVELOPMENT:
    - a. Credit MR 2: Waste management plan complying with Section 017419 "Construction Waste Management and Disposal."
    - b. Credit MR 3: List of proposed salvaged, refurbished, and reused materials. Identify each material that will be salvaged, refurbished, or reused, including its source, cost, and replacement cost if the item was to be purchased new.
    - c. Credit MR 4: List of proposed materials with recycled content. Indicate cost, post-consumer recycled content, and pre-consumer recycled content for each product having recycled content.
    - d. Credit MR 5: List of proposed regional materials. Identify each regional material, including its source, cost, and the fraction by weight that is considered regional.
    - e. Credit MR 6: List of proposed certified wood products. Indicate each product containing certified wood, including its source and cost of certified wood products.
    - f. Credit IEQ 3: Construction indoor-air-quality management plan.
  4. FOR SCHOOLS:
    - a. Credit MR 2: Waste management plan complying with Section 017419 "Construction Waste Management and Disposal."
    - b. Credit MR 3: List of proposed salvaged, refurbished, and reused materials. Identify each material that will be salvaged, refurbished, or reused, including its source, cost, and replacement cost if the item was to be purchased new.
    - c. Credit MR 4: List of proposed materials with recycled content. Indicate cost, post-consumer recycled content, and pre-consumer recycled content for each product having recycled content.
    - d. Credit MR 5: List of proposed regional materials. Identify each regional material, including its source, cost, and the fraction by weight that is considered regional.
    - e. Credit MR 7: List of proposed certified wood products. Indicate each product containing certified wood, including its source and cost of certified wood products.
    - f. Credit IEQ 3.1: Construction indoor-air-quality management plan.
- D. LEED Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with LEED action plans for the following:
1. FOR CONSTRUCTION AND MAJOR RENOVATIONS:
    - a. Credit MR 2: Waste reduction progress reports complying with Section 017419 "Construction Waste Management and Disposal."
    - b. Credit MR 3: Salvaged, refurbished, and reused materials.
    - c. Credit MR 4: Recycled content.
    - d. Credit MR 5: Regional materials.
    - e. Credit MR 7: Certified wood products.
  2. FOR COMMERCIAL INTERIORS:
    - a. Credit MR 2: Waste reduction progress reports complying with Section 017419 "Construction Waste Management and Disposal."
    - b. Credit MR 3.1 and Credit MR 3.2: Salvaged, refurbished, and reused materials.
    - c. Credit MR 4: Recycled content.
    - d. Credit MR 5: Regionally manufactured materials and regionally extracted and manufactured materials.
    - e. Credit MR 7: Certified wood products.
  3. FOR CORE AND SHELL DEVELOPMENT:
    - a. Credit MR 2: Waste reduction progress reports complying with Section 017419 "Construction Waste Management and Disposal."
    - b. Credit MR 3: Salvaged, refurbished, and reused materials.



- c. Credit MR 4: Recycled content.
- d. Credit MR 5: Regional materials.
- e. Credit MR 6: Certified wood products.
- 4. FOR SCHOOLS:
  - a. Credit MR 2: Waste reduction progress reports complying with Section 017419 "Construction Waste Management and Disposal."
  - b. Credit MR 3: Salvaged, refurbished, and reused materials.
  - c. Credit MR 4: Recycled content.
  - d. Credit MR 5: Regional materials.
  - e. Credit MR 7: Certified wood products.

## 1.6 QUALITY ASSURANCE

- A. LEED Coordinator: Engage an experienced LEED-Accredited Professional to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator.

## PART 2 - PRODUCTS

### 2.1 MATERIALS, GENERAL

- A. Provide products and procedures necessary to obtain LEED credits required in this Section. Although other Sections may specify some requirements that contribute to LEED credits, the Contractor shall determine additional materials and procedures necessary to obtain LEED credits indicated.

### 2.2 SALVAGED, REFURBISHED, OR REUSED MATERIALS

- A. FOR CONSTRUCTION AND MAJOR RENOVATIONS
  - 1. Credit MR 3: Not less than 5 **OR** 10 percent, **as directed**, of building materials (by cost) shall be salvaged, refurbished, or reused materials. Certain materials may be salvaged, refurbished, or reused materials **as directed**.
- B. FOR COMMERCIAL INTERIORS
  - 1. Credit MR 3.1 and Credit MR 3.2: Not less than 5 **OR** 10 percent, **as directed**, of building materials (by cost) shall be salvaged, refurbished, or reused materials.
- C. FOR CORE AND SHELL DEVELOPMENT
  - 1. Credit MR 3: Not less than 5 percent of building materials (by cost) shall be salvaged, refurbished, or reused materials.
- D. FOR SCHOOLS
  - 1. Credit MR 3: Not less than 1 percent of building materials (by cost) shall be salvaged, refurbished, or reused materials.

### 2.3 RECYCLED CONTENT OF MATERIALS

- A. Credit MR 4: Building materials shall have recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content for Project constitutes a minimum of 10 **OR** 20, **as directed**, percent of cost of materials used for Project.



1. Cost of post-consumer recycled content plus one-half of pre-consumer recycled content of an item shall be determined by dividing weight of post-consumer recycled content plus one-half of pre-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.
2. Do not include furniture, plumbing, mechanical and electrical components, and specialty items such as elevators and equipment in the calculation.

## 2.4 REGIONAL MATERIALS

- A. FOR CONSTRUCTION AND MAJOR RENOVATIONS, CORE AND SHELL DEVELOPMENT, and SCHOOLS
  1. Credit MR 5: Not less than 10 **OR** 20 percent, **as directed**, of building materials (by cost) shall be regional materials.
- B. FOR COMMERCIAL INTERIORS
  1. Credit MR 5, Option 1: Not less than 20 percent of materials (by cost) shall be regionally manufactured materials.
  2. Credit MR 5, Option 2: Not less than 10 percent of materials (by cost) shall be regionally extracted and manufactured materials.

## 2.5 CERTIFIED WOOD

- A. Wood-based materials include, but are not limited to, the following materials when made from wood, engineered wood products, or wood-based panel products:
  1. Rough carpentry.
  2. Miscellaneous carpentry.
  3. Heavy timber construction.
  4. Wood decking.
  5. Metal-plate-connected wood trusses.
  6. Structural glued-laminated timber.
  7. Finish carpentry.
  8. Architectural woodwork.
  9. Wood paneling.
  10. Wood veneer wall covering.
  11. Wood flooring.
  12. Wood lockers.
  13. Wood cabinets.
  14. Furniture
- B. FOR CONSTRUCTION AND MAJOR RENOVATIONS, COMMERCIAL INTERIORS , and SCHOOLS
  1. Credit MR 7: Not less than 50 percent (by cost) of wood-based materials shall be 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."
- C. FOR CORE AND SHELL DEVELOPMENT
  1. Credit MR 6: Not less than 50 percent (by cost) of wood-based materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."



## 2.6 LOW-EMITTING MATERIALS

### A. FOR CONSTRUCTION AND MAJOR RENOVATIONS, COMMERCIAL INTERIORS, and CORE AND SHELL DEVELOPMENT

1. Credit IEQ 4.1: For field applications that are inside the weatherproofing system, adhesives and sealants shall comply with the following VOC content limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
  - a. Wood Glues: 30 g/L.
  - b. Metal-to-Metal Adhesives: 30 g/L.
  - c. Adhesives for Porous Materials (Except Wood): 50 g/L.
  - d. Subfloor Adhesives: 50 g/L.
  - e. Plastic Foam Adhesives: 50 g/L.
  - f. Carpet Adhesives: 50 g/L.
  - g. Carpet Pad Adhesives: 50 g/L.
  - h. VCT and Asphalt Tile Adhesives: 50 g/L.
  - i. Cove Base Adhesives: 50 g/L.
  - j. Gypsum Board and Panel Adhesives: 50 g/L.
  - k. Rubber Floor Adhesives: 60 g/L.
  - l. Ceramic Tile Adhesives: 65 g/L.
  - m. Multipurpose Construction Adhesives: 70 g/L.
  - n. Fiberglass Adhesives: 80 g/L.
  - o. Contact Adhesive: 80 g/L.
  - p. Structural Glazing Adhesives: 100 g/L.
  - q. Wood Flooring Adhesive: 100 g/L.
  - r. Structural Wood Member Adhesive: 140 g/L.
  - s. Single-Ply Roof Membrane Adhesive: 250 g/L.
  - t. Special-Purpose Contact Adhesive (contact adhesive that is used to bond melamine-covered board, metal, unsupported vinyl, rubber, or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.
  - u. Top and Trim Adhesive: 250 g/L.
  - v. Plastic Cement Welding Compounds: 250 g/L.
  - w. ABS Welding Compounds: 325 g/L.
  - x. CPVC Welding Compounds: 490 g/L.
  - y. PVC Welding Compounds: 510 g/L.
  - z. Adhesive Primer for Plastic: 550 g/L.
  - aa. Sheet-Applied Rubber Lining Adhesive: 850 g/L.
  - bb. Aerosol Adhesive, General-Purpose Mist Spray: 65 percent by weight.
  - cc. Aerosol Adhesive, General-Purpose Web Spray: 55 percent by weight.
  - dd. Special-Purpose Aerosol Adhesive (All Types): 70 percent by weight.
  - ee. Other Adhesives: 250 g/L.
  - ff. Architectural Sealants: 250 g/L.
  - gg. Nonmembrane Roof Sealants: 300 g/L.
  - hh. Single-Ply Roof Membrane Sealants: 450 g/L.
  - ii. Other Sealants: 420 g/L.
  - jj. Sealant Primers for Nonporous Substrates: 250 g/L.
  - kk. Sealant Primers for Porous Substrates: 775 g/L.
  - ll. Modified Bituminous Sealant Primers: 500 g/L.
  - mm. Other Sealant Primers: 750 g/L.
2. Credit IEQ 4.2: For field applications that are inside the weatherproofing system, paints and coatings shall comply with the following VOC content limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
  - a. Flat Paints and Coatings: VOC not more than 50 g/L.
  - b. Nonflat Paints and Coatings: VOC not more than 150 g/L.
  - c. Dry-Fog Coatings: VOC not more than 400 g/L.
  - d. Primers, Sealers, and Undercoaters: VOC not more than 200 g/L.
  - e. Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.



- f. Zinc-Rich Industrial Maintenance Primers: VOC not more than 340 g/L.
  - g. Pretreatment Wash Primers: VOC not more than 420 g/L.
  - h. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
  - i. Clear Wood Finishes, Lacquers: VOC not more than 550 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. Stains: VOC not more than 250 g/L.
3. Credit IEQ 4.4: Composite wood, agrifiber products, and adhesives shall not contain urea-formaldehyde resin.

#### B. FOR SCHOOLS

- 1. Credit IEQ 4: The following products and systems, where installed inside the weatherproofing system, shall meet the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
  - a. Adhesives and sealants.
  - b. Paints and coatings.
  - c. Flooring systems.
  - d. Composite wood and agrifiber products.
  - e. Ceilings and wall systems.

### PART 3 - EXECUTION

#### 3.1 REFRIGERANT AND CLEAN-AGENT FIRE-EXTINGUISHING-AGENT REMOVAL

- A. Prerequisite EA 3: Remove CFC-based refrigerants from existing HVAC&R equipment indicated to remain and replace with refrigerants that are not CFC based. Replace or adjust existing equipment to accommodate new refrigerant as described in HVAC Sections.
- B. Credit EA 4: Remove clean-agent fire-extinguishing agents that contain HCFCs or halons and replace with agent that does not contain HCFCs or halons. See Section 212200 "Clean-Agent Fire-Extinguishing Systems" for additional requirements.

#### 3.2 MEASUREMENT AND VERIFICATION

##### A. FOR CONSTRUCTION AND MAJOR RENOVATIONS and SCHOOLS

- 1. Credit EA 5: Implement measurement and verification plan consistent with Option B: Energy Conservation Measure Isolation **OR** Option D: Calibrated Simulation, Savings Estimation Method 2, **as directed**, in the EVO's "International Performance Measurement and Verification Protocol (IPMVP), Volume III: Concepts and Options for Determining Energy Savings in New Construction," and **as directed**.

##### B. FOR COMMERCIAL INTERIORS

- 1. Credit EA 3: Implement measurement and verification plan consistent with Option B: Energy Conservation Measure Isolation **OR** Option D: Calibrated Simulation, Savings Estimation Method 2, **as directed**, in the EVO's "International Performance Measurement and Verification Protocol (IPMVP), Volume III: Concepts and Options for Determining Energy Savings in New Construction," and **as directed**.

##### C. FOR CORE AND SHELL DEVELOPMENT



1. Credit EA 5.1 and 5.2: Implement measurement and verification plan consistent with Option B: Energy Conservation Measure Isolation **OR** Option D: Calibrated Simulation, Savings Estimation Method 2, **as directed**, in the EVO's "International Performance Measurement and Verification Protocol (IPMVP), Volume III: Concepts and Options for Determining Energy Savings in New Construction," and **as directed**.
  - D. If not already in place, install metering equipment to measure energy usage. Monitor, record, and trend log measurements.
  - E. Evaluate energy performance and efficiency by comparing actual to predicted performance.
  - F. Measurement and verification period shall cover at least one year of postconstruction occupancy.
- 3.3 CONSTRUCTION WASTE MANAGEMENT
- A. Credit MR 2: Comply with Section 017419 "Construction Waste Management and Disposal."
- 3.4 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT
- A. Credit IEQ 3.1: Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction."
    1. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Section 015000 "Temporary Facilities and Controls," install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
    2. Replace all air filters immediately prior to occupancy.
  - B. Credit IEQ 3.2: Comply with one of the following requirements, **as directed**:
    1. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total volume of 14000 cu. ft. (4 300 000 L) of outdoor air per sq. ft. (sq. m) of floor area while maintaining an internal temperature of at least 60 deg F (16 deg C) and a relative humidity no higher than 60 percent.
    2. If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of 3500 cu. ft. (1 070 000 L) of outdoor air per sq. ft. (sq. m) of floor area to the space. Once a space is occupied, it shall be ventilated at a minimum rate of 0.30 cfm per sq. ft. (1.52 L/s per sq. m) of outside air or the design minimum outside air rate determined in Prerequisite IEQ 1, whichever is greater. During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of 14000 cu. ft./sq. ft. (4 300 000 L/sq. m) of outside air has been delivered to the space.
    3. Air-Quality Testing:
      - a. Conduct baseline indoor-air-quality testing, after construction ends and prior to occupancy, using testing protocols consistent with the EPA's "Compendium of Methods for the Determination of Air Pollutants in Indoor Air," and as additionally detailed in the USGBC's "Green Building Design and Construction Reference Guide."
      - b. Demonstrate that the contaminant maximum concentrations listed below are not exceeded:
        - 1) Formaldehyde: 27 ppb.
        - 2) Particulates (PM10): 50 micrograms/cu. m.



- 3) Total Volatile Organic Compounds (TVOC): 500 micrograms/cu. m.
  - 4) 4-Phenylcyclohexene (4-PH): 6.5 micrograms/cu. m.
  - 5) Carbon Monoxide: 9 ppm and no greater than 2 ppm above outdoor levels.
- c. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with outside air and retest the specific parameter(s) exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met. When retesting noncomplying building areas, take samples from same locations as in the first test.
- d. Air-sample testing shall be conducted as follows:
- 1) All measurements shall be conducted prior to occupancy but during normal occupied hours, and with building ventilation system starting at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.
  - 2) Building shall have all interior finishes installed including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Nonfixed furnishings such as workstations and partitions are encouraged, but not required, to be in place for the testing.
  - 3) Number of sampling locations varies depending on the size of building and number of ventilation systems. For each portion of building served by a separate ventilation system, the number of sampling points shall not be less than one per 25,000 sq. ft. (2300 sq. m) or for each contiguous floor area, whichever is larger, and shall include areas with the least ventilation and greatest presumed source strength.
  - 4) Air samples shall be collected between 3 and 6 feet (0.9 and 1.8 m) from the floor to represent the breathing zone of occupants, and over a minimum four-hour period.

END OF SECTION01 32 33 00b.13

**SECTION 01 32 33 00c - REFERENCES**

## 1.1 GENERAL

## A. Definitions

1. General: Basic Contract definitions are included in the Conditions of the Contract.
2. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
3. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
4. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
5. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
6. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
7. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
8. "Provide": Furnish and install, complete and ready for the intended use.
9. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

## B. Industry Standards

1. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
2. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
3. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
  - a. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

## C. Abbreviations And Acronyms

1. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

AA	Aluminum Association, Inc. (The) www.aluminum.org	(703) 358-2960
AAADM	American Association of Automatic Door Manufacturers www.aaadm.com	(216) 241-7333
AABC	Associated Air Balance Council www.aabchq.com	(202) 737-0202



AAMA	American Architectural Manufacturers Association www.aamanet.org	(847) 303-5664
AASHTO	American Association of State Highway and Transportation Officials www.transportation.org	(202) 624-5800
AATCC	American Association of Textile Chemists and Colorists (The) www.aatcc.org	(919) 549-8141
ABAA	Air Barrier Association of America www.airbarrier.org	(866) 956-5888
ABMA	American Bearing Manufacturers Association www.abma-dc.org	(202) 367-1155
ACI	ACI International (American Concrete Institute) www.aci-int.org	(248) 848-3700
ACPA	American Concrete Pipe Association www.concrete-pipe.org	(972) 506-7216
AEIC	Association of Edison Illuminating Companies, Inc. (The) www.aeic.org	(205) 257-2530
AF&PA	American Forest & Paper Association www.afandpa.org	(800) 878-8878 (202) 463-2700
AGA	American Gas Association www.aga.org	(202) 824-7000
AGC	Associated General Contractors of America (The) www.agc.org	(703) 548-3118
AHA	American Hardboard Association (Now part of CPA)	
AHAM	Association of Home Appliance Manufacturers www.aham.org	(202) 872-5955
AI	Asphalt Institute www.asphaltinstitute.org	(859) 288-4960
AIA	American Institute of Architects (The) www.aia.org	(800) 242-3837 (202) 626-7300
AISC	American Institute of Steel Construction www.aisc.org	(800) 644-2400 (312) 670-2400
AISI	American Iron and Steel Institute www.steel.org	(202) 452-7100
AITC	American Institute of Timber Construction	(303) 792-9559



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	<a href="http://www.aitc-glulam.org">www.aitc-glulam.org</a>	
ALCA	Associated Landscape Contractors of America (Now PLANET - Professional Landcare Network)	
ALSC	American Lumber Standard Committee, Incorporated <a href="http://www.alsc.org">www.alsc.org</a>	(301) 972-1700
AMCA	Air Movement and Control Association International, Inc. <a href="http://www.amca.org">www.amca.org</a>	(847) 394-0150
ANSI	American National Standards Institute <a href="http://www.ansi.org">www.ansi.org</a>	(202) 293-8020
AOSA	Association of Official Seed Analysts, Inc. <a href="http://www.aosaseed.com">www.aosaseed.com</a>	(405) 780-7372
APA	Architectural Precast Association <a href="http://www.archprecast.org">www.archprecast.org</a>	(239) 454-6989
APA	APA - The Engineered Wood Association <a href="http://www.apawood.org">www.apawood.org</a>	(253) 565-6600
APA EWS	APA - The Engineered Wood Association; Engineered Wood Systems (See APA - The Engineered Wood Association)	
API	American Petroleum Institute <a href="http://www.api.org">www.api.org</a>	(202) 682-8000
ARI	Air-Conditioning & Refrigeration Institute <a href="http://www.ari.org">www.ari.org</a>	(703) 524-8800
ARMA	Asphalt Roofing Manufacturers Association <a href="http://www.asphaltroofing.org">www.asphaltroofing.org</a>	(202) 207-0917
ASCE	American Society of Civil Engineers <a href="http://www.asce.org">www.asce.org</a>	(800) 548-2723 (703) 295-6300
ASCE/SEI	American Society of Civil Engineers/Structural Engineering Institute (See ASCE)	
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers <a href="http://www.ashrae.org">www.ashrae.org</a>	(800) 527-4723 (404) 636-8400
ASME	ASME International (The American Society of Mechanical Engineers International) <a href="http://www.asme.org">www.asme.org</a>	(800) 843-2763 (973) 882-1170
ASSE	American Society of Sanitary Engineering <a href="http://www.asse-plumbing.org">www.asse-plumbing.org</a>	(440) 835-3040
ASTM	ASTM International (American Society for Testing and Materials International)	(610) 832-9585



	<a href="http://www.astm.org">www.astm.org</a>	
AWCI	AWCI International (Association of the Wall and Ceiling Industry International) <a href="http://www.awci.org">www.awci.org</a>	(703) 534-8300
AWCMA	American Window Covering Manufacturers Association (Now WCSC)	
AWI	Architectural Woodwork Institute <a href="http://www.awinet.org">www.awinet.org</a>	(571) 323-3636
AWPA	American Wood-Preservers' Association <a href="http://www.awpa.com">www.awpa.com</a>	(205) 733-4077
AWS	American Welding Society <a href="http://www.aws.org">www.aws.org</a>	(800) 443-9353 (305) 443-9353
AWWA	American Water Works Association <a href="http://www.awwa.org">www.awwa.org</a>	(800) 926-7337 (303) 794-7711
BHMA	Builders Hardware Manufacturers Association <a href="http://www.buildershardware.com">www.buildershardware.com</a>	(212) 297-2122
BIA	Brick Industry Association (The) <a href="http://www.bia.org">www.bia.org</a>	(703) 620-0010
BICSI	Building Industry Consulting Service International <a href="http://www.bicsi.org">www.bicsi.org</a>	(800) 242-7405 (813) 979-1991
BIFMA	BIFMA International (Business and Institutional Furniture Manufacturer's Association International) <a href="http://www.bifma.com">www.bifma.com</a>	(616) 285-3963
BISSC	Baking Industry Sanitation Standards Committee <a href="http://www.bissc.org">www.bissc.org</a>	(866) 342-4772
CCC	Carpet Cushion Council <a href="http://www.carpetcushion.org">www.carpetcushion.org</a>	(610) 527-3880
CDA	Copper Development Association <a href="http://www.copper.org">www.copper.org</a>	(800) 232-3282 (212) 251-7200
CEA	Canadian Electricity Association <a href="http://www.canelect.ca">www.canelect.ca</a>	(613) 230-9263
CFFA	Chemical Fabrics & Film Association, Inc. <a href="http://www.chemicalfabricsandfilm.com">www.chemicalfabricsandfilm.com</a>	(216) 241-7333
CGA	Compressed Gas Association <a href="http://www.cganet.com">www.cganet.com</a>	(703) 788-2700
CIMA	Cellulose Insulation Manufacturers Association <a href="http://www.cellulose.org">www.cellulose.org</a>	(888) 881-2462 (937) 222-2462



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CISCA	Ceilings & Interior Systems Construction Association <a href="http://www.cisca.org">www.cisca.org</a>	(630) 584-1919
CISPI	Cast Iron Soil Pipe Institute <a href="http://www.cispi.org">www.cispi.org</a>	(423) 892-0137
CLFMI	Chain Link Fence Manufacturers Institute <a href="http://www.chainlinkinfo.org">www.chainlinkinfo.org</a>	(301) 596-2583
CRRC	Cool Roof Rating Council <a href="http://www.coolroofs.org">www.coolroofs.org</a>	(866) 465-2523 (510) 485-7175
CPA	Composite Panel Association <a href="http://www.pbmdf.com">www.pbmdf.com</a>	(301) 670-0604
CPPA	Corrugated Polyethylene Pipe Association <a href="http://www.cppa-info.org">www.cppa-info.org</a>	(800) 510-2772 (202) 462-9607
CRI	Carpet & Rug Institute (The) <a href="http://www.carpet-rug.com">www.carpet-rug.com</a>	(800) 882-8846 (706) 278-3176
CRSI	Concrete Reinforcing Steel Institute <a href="http://www.crsi.org">www.crsi.org</a>	(847) 517-1200
CSA	Canadian Standards Association	(800) 463-6727 (416) 747-4000
CSA	CSA International (Formerly: IAS - International Approval Services) <a href="http://www.csa-international.org">www.csa-international.org</a>	(866) 797-4272 (416) 747-4000
CSI	Cast Stone Institute <a href="http://www.caststone.org">www.caststone.org</a>	(717) 272-3744
CSI	Construction Specifications Institute (The) <a href="http://www.csinet.org">www.csinet.org</a>	(800) 689-2900 (703) 684-0300
CSSB	Cedar Shake & Shingle Bureau <a href="http://www.cedarbureau.org">www.cedarbureau.org</a>	(604) 820-7700
CTI	Cooling Technology Institute (Formerly: Cooling Tower Institute) <a href="http://www.cti.org">www.cti.org</a>	(281) 583-4087
DHI	Door and Hardware Institute <a href="http://www.dhi.org">www.dhi.org</a>	(703) 222-2010
EIA	Electronic Industries Alliance <a href="http://www.eia.org">www.eia.org</a>	(703) 907-7500
EIMA	EIFS Industry Members Association <a href="http://www.eima.com">www.eima.com</a>	(800) 294-3462 (770) 968-7945
EJCDC	Engineers Joint Contract Documents Committee <a href="http://www.ejdc.org">www.ejdc.org</a>	(703) 295-5000



EJMA	Expansion Joint Manufacturers Association, Inc. www.ejma.org	(914) 332-0040
ESD	ESD Association www.esda.org	(315) 339-6937
FIBA	Federation Internationale de Basketball (The International Basketball Federation) www.fiba.com	41 22 545 00 00
FIVB	Federation Internationale de Volleyball (The International Volleyball Federation) www.fivb.ch	41 21 345 35 35
FM Approvals	FM Approvals www.fmglobal.com	(781) 762-4300
FM Global	FM Global (Formerly: FMG - FM Global) www.fmglobal.com	(401) 275-3000
FMRC	Factory Mutual Research (Now FM Global)	
FRSA	Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc. www.floridarroof.com	(407) 671-3772
FSA	Fluid Sealing Association www.fluidsealing.com	(610) 971-4850
FSC	Forest Stewardship Council www.fsc.org	49 228 367 66 0
GA	Gypsum Association www.gypsum.org	(202) 289-5440
GANA	Glass Association of North America www.glasswebsite.com	(785) 271-0208
GRI	(Now GSI)	
GS	Green Seal www.greenseal.org	(202) 872-6400
GSI	Geosynthetic Institute www.geosynthetic-institute.org	(610) 522-8440
HI	Hydraulic Institute www.pumps.org	(888) 786-7744 (973) 267-9700
HI	Hydronics Institute www.gamanet.org	(908) 464-8200



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HMMA	Hollow Metal Manufacturers Association (Part of NAAMM)	
HPVA	Hardwood Plywood & Veneer Association <a href="http://www.hpva.org">www.hpva.org</a>	(703) 435-2900
HPW	H. P. White Laboratory, Inc. <a href="http://www.hpwhite.com">www.hpwhite.com</a>	(410) 838-6550
IAS	International Approval Services (Now CSA International)	
IBF	International Badminton Federation <a href="http://www.internationalbadminton.org">www.internationalbadminton.org</a>	(6-03) 9283-7155
ICEA	Insulated Cable Engineers Association, Inc. <a href="http://www.icea.net">www.icea.net</a>	(770) 830-0369
ICRI	International Concrete Repair Institute, Inc. <a href="http://www.icri.org">www.icri.org</a>	(847) 827-0830
IEC	International Electrotechnical Commission <a href="http://www.iec.ch">www.iec.ch</a>	41 22 919 02 11
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The) <a href="http://www.ieee.org">www.ieee.org</a>	(212) 419-7900
IESNA	Illuminating Engineering Society of North America <a href="http://www.iesna.org">www.iesna.org</a>	(212) 248-5000
IEST	Institute of Environmental Sciences and Technology <a href="http://www.iest.org">www.iest.org</a>	(847) 255-1561
IGCC	Insulating Glass Certification Council <a href="http://www.igcc.org">www.igcc.org</a>	(315) 646-2234
IGMA	Insulating Glass Manufacturers Alliance <a href="http://www.igmaonline.org">www.igmaonline.org</a>	(613) 233-1510
ILI	Indiana Limestone Institute of America, Inc. <a href="http://www.iliai.com">www.iliai.com</a>	(812) 275-4426
ISO	International Organization for Standardization <a href="http://www.iso.ch">www.iso.ch</a>	41 22 749 01 11
	Available from ANSI <a href="http://www.ansi.org">www.ansi.org</a>	(202) 293-8020
ISSFA	International Solid Surface Fabricators Association <a href="http://www.issfa.net">www.issfa.net</a>	(877) 464-7732 (702) 567-8150
ITS	Intertek Testing Service NA <a href="http://www.intertek.com">www.intertek.com</a>	(972) 238-5591
ITU	International Telecommunication Union <a href="http://www.itu.int/home">www.itu.int/home</a>	41 22 730 51 11



KCMA	Kitchen Cabinet Manufacturers Association <a href="http://www.kcma.org">www.kcma.org</a>	(703) 264-1690
LMA	Laminating Materials Association (Now part of CPA)	
LPI	Lightning Protection Institute <a href="http://www.lightning.org">www.lightning.org</a>	(800) 488-6864
MBMA	Metal Building Manufacturers Association <a href="http://www.mbma.com">www.mbma.com</a>	(216) 241-7333
MFMA	Maple Flooring Manufacturers Association, Inc. <a href="http://www.maplefloor.org">www.maplefloor.org</a>	(847) 480-9138
MFMA	Metal Framing Manufacturers Association, Inc. <a href="http://www.metalframingmfg.org">www.metalframingmfg.org</a>	(312) 644-6610
MH	Material Handling (Now MHIA)	
MHIA	Material Handling Industry of America <a href="http://www.mhia.org">www.mhia.org</a>	(800) 345-1815 (704) 676-1190
MIA	Marble Institute of America <a href="http://www.marble-institute.com">www.marble-institute.com</a>	(440) 250-9222
MPI	Master Painters Institute <a href="http://www.paintinfo.com">www.paintinfo.com</a>	(888) 674-8937
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc. <a href="http://www.mss-hq.com">www.mss-hq.com</a>	(703) 281-6613
NAAMM	National Association of Architectural Metal Manufacturers <a href="http://www.naamm.org">www.naamm.org</a>	(312) 332-0405
NACE	NACE International (National Association of Corrosion Engineers International) <a href="http://www.nace.org">www.nace.org</a>	(800) 797-6623 (281) 228-6200
NADCA	National Air Duct Cleaners Association <a href="http://www.nadca.com">www.nadca.com</a>	(202) 737-2926
NAGWS	National Association for Girls and Women in Sport <a href="http://www.aahperd.org/nagws/">www.aahperd.org/nagws/</a>	(800) 213-7193, ext. 453
NAIMA	North American Insulation Manufacturers Association <a href="http://www.naima.org">www.naima.org</a>	(703) 684-0084
NBGQA	National Building Granite Quarries Association, Inc. <a href="http://www.nbgqa.com">www.nbgqa.com</a>	(800) 557-2848



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NCAA	National Collegiate Athletic Association (The) www.ncaa.org	(317) 917-6222
NCMA	National Concrete Masonry Association www.ncma.org	(703) 713-1900
NCPI	National Clay Pipe Institute www.ncpi.org	(262) 248-9094
NCTA	National Cable & Telecommunications Association www.ncta.com	(202) 775-3550
NEBB	National Environmental Balancing Bureau www.nebb.org	(301) 977-3698
NECA	National Electrical Contractors Association www.necanet.org	(301) 657-3110
NeLMA	Northeastern Lumber Manufacturers' Association www.nelma.org	(207) 829-6901
NEMA	National Electrical Manufacturers Association www.nema.org	(703) 841-3200
NETA	InterNational Electrical Testing Association www.netaworld.org	(888) 300-6382 (303) 697-8441
NFHS	National Federation of State High School Associations www.nfhs.org	(317) 972-6900
NFPA	NFPA (National Fire Protection Association) www.nfpa.org	(800) 344-3555 (617) 770-3000
NFRC	National Fenestration Rating Council www.nfrc.org	(301) 589-1776
NGA	National Glass Association www.glass.org	(866) 342-5642 (703) 442-4890
NHLA	National Hardwood Lumber Association www.natlhardwood.org	(800) 933-0318 (901) 377-1818
NLGA	National Lumber Grades Authority www.nlga.org	(604) 524-2393
NOFMA	NOFMA: The Wood Flooring Manufacturers Association (Formerly: National Oak Flooring Manufacturers Association) www.nofma.com	(901) 526-5016
NRCA	National Roofing Contractors Association www.nrca.net	(800) 323-9545 (847) 299-9070
NRMCA	National Ready Mixed Concrete Association www.nrmca.org	(888) 846-7622 (301) 587-1400



NSF	NSF International (National Sanitation Foundation International) www.nsf.org	(800) 673-6275 (734) 769-8010
NSSGA	National Stone, Sand & Gravel Association www.nssga.org	(800) 342-1415 (703) 525-8788
NTMA	National Terrazzo & Mosaic Association, Inc. (The) www.ntma.com	(800) 323-9736 (540) 751-0930
NTRMA	National Tile Roofing Manufacturers Association (Now TRI)	
NWWDA	National Wood Window and Door Association (Now WDMA)	
OPL	Omega Point Laboratories, Inc. (Now ITS)	
PCI	Precast/Prestressed Concrete Institute www.pci.org	(312) 786-0300
PDCA	Painting & Decorating Contractors of America www.pdca.com	(800) 332-7322 (314) 514-7322
PDI	Plumbing & Drainage Institute www.pdionline.org	(800) 589-8956 (978) 557-0720
PGI	PVC Geomembrane Institute http://pgi-tp.ce.uiuc.edu	(217) 333-3929
PLANET	Professional Landcare Network (Formerly: ACLA - Associated Landscape Contractors of America) www.landcarenetwork.org	(800) 395-2522 (703) 736-9666
PTI	Post-Tensioning Institute www.post-tensioning.org	(602) 870-7540
RCSC	Research Council on Structural Connections www.boltcouncil.org	
RFCI	Resilient Floor Covering Institute www.rfci.com	(301) 340-8580
RIS	Redwood Inspection Service www.calredwood.org	(888) 225-7339 (415) 382-0662
SAE	SAE International www.sae.org	(877) 606-7323 (724) 776-4841
SDI	Steel Deck Institute www.sdi.org	(847) 458-4647
SDI	Steel Door Institute	(440) 899-0010



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	<a href="http://www.steeldoor.org">www.steeldoor.org</a>	
SEFA	Scientific Equipment and Furniture Association <a href="http://www.sefalabs.com">www.sefalabs.com</a>	(516) 294-5424
SEI/ASCE	Structural Engineering Institute/American Society of Civil Engineers (See ASCE)	
SGCC	Safety Glazing Certification Council <a href="http://www.sgcc.org">www.sgcc.org</a>	(315) 646-2234
SIA	Security Industry Association <a href="http://www.siaonline.org">www.siaonline.org</a>	(703) 683-2075
SIGMA	Sealed Insulating Glass Manufacturers Association (Now IGMA)	
SJI	Steel Joist Institute <a href="http://www.steeljoist.org">www.steeljoist.org</a>	(843) 626-1995
SMA	Screen Manufacturers Association <a href="http://www.smacentral.org">www.smacentral.org</a>	(561) 533-0991
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association <a href="http://www.smacna.org">www.smacna.org</a>	(703) 803-2980
SMPTE	Society of Motion Picture and Television Engineers <a href="http://www.smpte.org">www.smpte.org</a>	(914) 761-1100
SPFA	Spray Polyurethane Foam Alliance (Formerly: SPI/SPFD - The Society of the Plastics Industry, Inc.; Spray Polyurethane Foam Division) <a href="http://www.sprayfoam.org">www.sprayfoam.org</a>	(800) 523-6154
SPIB	Southern Pine Inspection Bureau (The) <a href="http://www.spib.org">www.spib.org</a>	(850) 434-2611
SPRI	Single Ply Roofing Industry <a href="http://www.spri.org">www.spri.org</a>	(781) 647-7026
SSINA	Specialty Steel Industry of North America <a href="http://www.ssina.com">www.ssina.com</a>	(800) 982-0355 (202) 342-8630
SSPC	SSPC: The Society for Protective Coatings <a href="http://www.sspc.org">www.sspc.org</a>	(877) 281-7772 (412) 281-2331
STI	Steel Tank Institute <a href="http://www.steeltank.com">www.steeltank.com</a>	(847) 438-8265
SWI	Steel Window Institute <a href="http://www.steelwindows.com">www.steelwindows.com</a>	(216) 241-7333
SWRI	Sealant, Waterproofing, & Restoration Institute <a href="http://www.swrionline.org">www.swrionline.org</a>	(816) 472-7974



TCA	Tile Council of America, Inc. www.tileusa.com	(864) 646-8453
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance www.tiaonline.org	(703) 907-7700
TMS	The Masonry Society www.masonrysociety.org	(303) 939-9700
TPI	Truss Plate Institute, Inc. www.tpinst.org	(703) 683-1010
TPI	Turfgrass Producers International www.turfgrassod.org	(800) 405-8873 (847) 649-5555
TRI	Tile Roofing Institute www.tilerroofing.org	(312) 670-4177
UL	Underwriters Laboratories Inc. www.ul.com	(877) 854-3577 (847) 272-8800
UNI	Uni-Bell PVC Pipe Association www.uni-bell.org	(972) 243-3902
USAV	USA Volleyball www.usavolleyball.org	(888) 786-5539 (719) 228-6800
USGBC	U.S. Green Building Council www.usgbc.org	(202) 828-7422
USITT	United States Institute for Theatre Technology, Inc. www.usitt.org	(800) 938-7488 (315) 463-6463
WASTEC	Waste Equipment Technology Association www.wastec.org	(800) 424-2869 (202) 244-4700
WCLIB	West Coast Lumber Inspection Bureau www.wclib.org	(800) 283-1486 (503) 639-0651
WCMA	Window Covering Manufacturers Association (Now WCSC)	
WCSC	Window Covering Safety Council (Formerly: WCMA - Window Covering Manufacturers Association) www.windowcoverings.org	(800) 506-4636 (212) 297-2109
WDMA	Window & Door Manufacturers Association (Formerly: NWWDA - National Wood Window and Door Association) www.wdma.com	(800) 223-2301 (847) 299-5200
WI	Woodwork Institute (Formerly: WIC - Woodwork Institute of	(916) 372-9943



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	California) www.wicnet.org	
WIC	Woodwork Institute of California (Now WI)	
WMMPA	Wood Moulding & Millwork Producers Association www.wmmpa.com	(800) 550-7889 (530) 661-9591
WSRCA	Western States Roofing Contractors Association www.wsrca.com	(800) 725-0333 (650) 570-5441
WWPA	Western Wood Products Association www.wwpa.org	(503) 224-3930
2.	Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.	
IAPMO	International Association of Plumbing and Mechanical Officials www.iapmo.org	(909) 472-4100
IBC	International Building Code (See ICC)	
ICBO	International Conference of Building Officials (See ICC)	
ICBO ES	ICBO Evaluation Service, Inc. (See ICC-ES)	
ICC	International Code Council www.iccsafe.org	(888) 422-7233 (703) 931-4533
ICC-ES	ICC Evaluation Service, Inc. www.icc-es.org	(800) 423-6587 (562) 699-0543
SBCCI	Southern Building Code Congress International, Inc. (See ICC)	
3.	Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.	
CE	Army Corps of Engineers www.usace.army.mil	
CPSC	Consumer Product Safety Commission www.cpsc.gov	(800) 638-2772 (301) 504-7923
DOC	Department of Commerce www.commerce.gov	(202) 482-2000




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DOD	Department of Defense <a href="http://.dodssp.daps.dla.mil">http://.dodssp.daps.dla.mil</a>	(215) 697-6257
DOE	Department of Energy <a href="http://www.energy.gov">www.energy.gov</a>	(202) 586-9220
EPA	Environmental Protection Agency <a href="http://www.epa.gov">www.epa.gov</a>	(202) 272-0167
FAA	Federal Aviation Administration <a href="http://www.faa.gov">www.faa.gov</a>	(866) 835-5322
FCC	Federal Communications Commission <a href="http://www.fcc.gov">www.fcc.gov</a>	(888) 225-5322
FDA	Food and Drug Administration <a href="http://www.fda.gov">www.fda.gov</a>	(888) 463-6332
GSA	General Services Administration <a href="http://www.gsa.gov">www.gsa.gov</a>	(800) 488-3111
HUD	Department of Housing and Urban Development <a href="http://www.hud.gov">www.hud.gov</a>	(202) 708-1112
LBL	Lawrence Berkeley National Laboratory <a href="http://www.lbl.gov">www.lbl.gov</a>	(510) 486-4000
NCHRP	National Cooperative Highway Research Program (See TRB)	
NIST	National Institute of Standards and Technology <a href="http://www.nist.gov">www.nist.gov</a>	(301) 975-6478
OSHA	Occupational Safety & Health Administration <a href="http://www.osha.gov">www.osha.gov</a>	(800) 321-6742 (202) 693-1999
PBS	Public Building Service (See GSA)	
PHS	Office of Public Health and Science <a href="http://www.osophs.dhhs.gov/ophs">www.osophs.dhhs.gov/ophs</a>	(202) 690-7694
RUS	Rural Utilities Service (See USDA)	(202) 720-9540
SD	State Department <a href="http://www.state.gov">www.state.gov</a>	(202) 647-4000
TRB	Transportation Research Board <a href="http://gulliver.trb.org">http://gulliver.trb.org</a>	(202) 334-2934
USDA	Department of Agriculture <a href="http://www.usda.gov">www.usda.gov</a>	(202) 720-2791





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list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CBHF	State of California, Department of Consumer Affairs Bureau of Home Furnishings and Thermal Insulation <a href="http://www.dca.ca.gov/bhfti">www.dca.ca.gov/bhfti</a>	(800) 952-5210 (916) 574-2041
CCR	California Code of Regulations <a href="http://www.calregs.com">www.calregs.com</a>	(916) 323-6815
CPUC	California Public Utilities Commission <a href="http://www.cpuc.ca.gov">www.cpuc.ca.gov</a>	(415) 703-2782
TFS	Texas Forest Service Forest Resource Development <a href="http://txforestservation.tamu.edu">http://txforestservation.tamu.edu</a>	(979) 458-6650

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 32 33 00c

**SECTION 01 32 33 00d - ABBREVIATIONS, ACRONYMS, DEFINITIONS, AND SYMBOLS**

## 1.1 GENERAL

## A. Description Of Work

1. This specification covers abbreviations, acronyms, definitions, and symbols used in the Contract Documents.

## B. Unit of Measure Definitions

1. Following is a list of Industry Standard abbreviations.

A	Area Square Feet; Ampere	B&W	Black and White
AB	Anchor Bolt	BC	Between Centers
ABC	Aggregate Base Course	BCY	Bank Cubic Yard
ABS	Acrylonitrile Butadiene Styrene	BDL	Bundle
AC	Alternating Current; Air-Conditioning; Asphaltic Concrete; Plywood Grade A & C	BD FT	Board Feet
ACFM	Actual Cubic Feet Per Minute	BEV	Bevel/Beveled
ACM	Asbestos Containing Material	BF	Board Feet
ACP	Asphaltic Concrete Paving	BFP	Boiler Feed Pump
ACR	Acre	BHN	Brinell Hardness Number
ACZA	Ammoniacal Copper Zinc Arsenate	BHP	Boiler Horsepower; Brake Horsepower
AD	Plywood, Grade A & D	BI	Black Iron
ADDL	Additional	Bit.	Bituminous
ADJ	Adjustable	Bitum.	Bituminous
ADMIN	Administer; Administration	Bk.	Backed
AGG	Aggregate	Brkrs.	Breakers
AH	Ampere Hours	Bldg.	Building
AHM	Ampere-Hour Meter	BLK	Black; Block
AHU	Air Handling Unit	BM	Bank Measure; Beam
AIC	Amperes Interrupting Capacity	BOD	Biochemical Oxygen Demand
AL	Aluminum	BOX	Box (each)
ALT	Alternate	BR	Bedroom
AMP	Ampere	Brg.	Bearing
AMT	Amount	BRK	Brick
AOT	Adjusted Oxygen Transfer	BTFLY VLV	Butterfly Valve
APP	Attactic Polypropylene	BTR	Better (Lumber)
APPROX	Approximate	BTU	British Thermal Units
Apt.	Apartment	BTU/HR	British Thermal Units per Hour
ART	Articulated	BUR	Built Up Roof
ASB	Asbestos	BW	Butt Weld
ASJ	All Surface Jacketing	BWG	Birmingham Wire Gauge
Avg.	Average	BX	Interlocked Armored Cable
AWG	American Wire Gauge	C	Centigrade; Conductance; Conductivity, Hundred
BAG	Bag	CA	Corrosion Allowance
BBL	Barrel	Cab.	Cabinet
B&B	Grade B and Better; Balled & Burlapped	CAP	Capacity
B&S	Bell and Spigot	CB	Circuit Breaker
		CC	Center to Center
		CCA	Chromate Copper Arsenate
		CCF	Hundred Cubic Feet



CCY	Compacted Cubic Yard	Dis.	Discharge
cd	Candela	Disch.	Discharge
cd/sf	Candela per Square Foot	DB	Dry Bulb; Decibel
CF	Cubic Foot (Feet)	DBL	Double
CFM	Cubic Feet per Minute	DC	Direct Current
CHG	Charge	DCS	Distributed Control System
CHW	Chilled Water; Commercial Hot Water	DDC	Direct Digital Control
CI	Cast Iron	Demob	Demobilization
CIP	Cast in Place; Cast Iron Pipe	DF	Douglas Fir
CIRC	Circulating; Circuit	DFT	Dry Film Thickness
CLF	Hundred Linear Feet; Current Limiting Fuse	DH	Double Hung
CLP	Cross Linked Polyethylene	DHW	Domestic Hot Water
cm	Centimeter	DI	Ductile Iron
CMP	Corrugated Metal Pipe	D/P	Differential Pressure
CMPA	Corrugated Metal Pipe - Arched	DIA	Diameter
CMU	Concrete Masonry Unit	Diam	Diameter
CO	Carbon Monoxide	Diag.	Diagonal
CO2	Carbon Dioxide	Distrib.	Distribution
COL	Column	DL	Dead Load; Diesel
Comb	Combination	DLH	Deep Long Span Bar Joist
Compr	Compressor	DPST	Double Pole, Single Throw
CONC	Concrete	DS	Double Strength
CONSTR	Construction	DSA	Double Strength A Quality Glass
Cont	Continuous; Continued	DSB	Double Strength B Quality Glass
Corr	Corrugated	DWV	Drain, Waste, Vent Piping
CP	Chrome Plated	DX	Deluxe White, Direct Expansion
CPE	Chlorinated Polyethylene	dyn	Dyne
Cplg.	Coupling	e	Eccentricity
CPM	Cycles per Minute	E	Electrical Grade (Fiberglass Construction)
CPM	Critical Path Method	EA	Each
CPS	Centipoise	Econ.	Economy
CPRSR	Compressor	ECR	Electrical Grade, Corrosion Resistant (Fiberglass Construction)
CPVC	Chlorinated Polyvinyl Chloride	EDP	Electronic Data Processing
CS	Carbon Steel	EDR	Equiv. Direct Radiation
CSF	Hundred Square Feet	EG	Electro Galvanized
CSPE	ChloroSulphinated Polyethylene	EIFS	Exterior Insulation Finish System
CSS	Cast Semi Steel	ELEC	Electric; Electrical
CT	Current Transformer	Elev.	Elevator; Elevating
CTB	Cement Treated Base	EM	Electron Microscopy
CTR	Center	EMT	Electric Metallic Tubing; Thin Wall Conduit
CU FT	Cubic Foot	Eng.	Engine, Engineered
CU IN	Cubic Inch	EPDM	Ethylene Propylene Diene Monomer
CU YD	Cubic Yard	EPS	Expanded Polystyrene
CW	Chilled Water; Cold Water	EQL	Equally
CWR	Chilled Water Return	Equip.	Equipment
CWS	Chilled Water Supply	ERW	Electrical Resistance Welded
CWT	Hundred Weight	EROPS	Enclosed Roll Over Protection System
CY	Cubic Yard (27 cu. ft.); Cycle	ES	Energy Saver
CYH	Cubic Yards Per Hour	Est.	Estimated
Cyl	Cylinder	EW	Each Way
d	Penny (nail size)	EWT	Entering Water Temperature
D	Deep; Depth; Discharge		



Excav.	Excavation	Gen.	General
EXH	Exhaust	GFCI	Ground Fault Circuit Interrupter
Exp.	Expansion; Exposure	GFR	Ground Fault Relay
EXP JT	Expansion Joint	GPD	Gallons per Day
Ext.	Exterior	GPH	Gallon per Hour
		GPM	Gallon per Minute
F	Fahrenheit; Female; Fill	GR	Grade
f	Fiber stress	Grnd.	Ground
f <sub>c</sub>	Compressive Stress in Concrete	GSF	Ground Square Foot
f <sub>y</sub>	Minimum Yield Stress of Steel	GVW	Gross Vehicle Weight
f <sub>m</sub>	Compressive Strength of Masonry		
F&D	Flanged-and-Dished	H	High, Height; High Strength Bar Joist
F&I	Furnished and Installed	HC	Handicapped; High Capacity
Fab.	Fabricated	HD	High Density; Heavy Duty
FAD	Free Air Delivery	HDO	High Density Overlay
FBGS	Fiberglass	HDPE	High Density Polyethylene
FC	Footcandles	Hdr.	Header
FCXP	Fan Cooled Explosion Proof	Hdw.	Hardware
FDA	Food and Drug Administration	HEPA	High Efficiency Particulate Air
FEP	Fluorinated Ethylene Propylene (Teflon)	Hg	Mercury
FF	Flat Face	HIC	High Interrupting Capacity
Fig.	Figure	HM	Hollow Metal
Fin.	Finished	HNDL	Handle
FL	Full Load	HO	High Output; Heel Outlet
FLDG	Folding	Horiz.	Horizontal
Fl. Oz.	Fluid Ounces	HP	High Pressure; Horse Power
Flr.	Floor	HPF	High Pressure Factor
FM	Frequency Modulation; Factory Mutual	HPL	High Pressure Laminate
Frmg.	Framing	HR	Hour
Fndtn.	Foundation	HRS	Hot-Rolled Steel
FT	Foot, Feet	HS	High Speed; High Strength
FTNG(S)	Fitting(s)	HSC	High Short Circuit
FLG	Flange	HSLA	High Strength Low Alloy
FOB	Freight on Board	HT	Hospital Tips; Height
Fount.	Fountain	Htg.	Heating
FPM	Feet Per Minute	Htrs.	Heaters
FPS	Feet Per Second	HVAC	Heating, Ventilating & Air Conditioning
FPT	Female Pipe Thread	Hvy.	Heavy
FRP	Fiberglass Reinforced Plastic	HW	Hot Water
FS	Forged Steel	HWR	Hot Water Return
FSC	Cast Body, Cast Switch Box	HWS	Hot Water Supply
Ftg.	Footing	HWT	Hundred Carton Weight
Ft. Lb.	Foot Pound	Hyd.	Hydraulic
Furn.	Furniture	Hydr.	Hydraulic
FVNR	Full Voltage Non-Reversing	HZ	Hertz (cycles)
FXM	Female by Male		
		I	Moment of Inertia
G	Gravity	IC	Interrupt Capacity
g	Gram	ICFM	Inlet Cubic Feet per Minute
GA	Gauge or Gage	ID	Inside Diameter
G & A	General and Administrative	I.D.	Identification; Inside Dimension
GAL	Gallon	IF	Inside Frosted
Gal./Min.	Gallon per Minute	IMC	Intermediate Metal Conduit
GALV	Galvanized	IN	Inch
GBSD	Gear Box Sheave Diameter	IN LB	Inch Pound
		IN WC	Inches Water Column



Incan.	Incandescent	LE	Leading Edge; Lead Equivalent
Incl.	Include, Including	LED	Light Emitting Diode
Inst.	Install, Installation	LEL	Lower Explosive Limit
Insul.	Insulation, Insulated	LF	Linear Foot
Int.	Interior	LFD	Linear Feet Per Day
INTSCT	Intersect	LFTL	Lineal Feet Tube Length
IP	Iron Pipe	Lge.	Large; Long
IPS	International Pipe Standard	LH	Labor Hours; Long Span Bar Joist
	Iron Pipe Size	LIN	Linear
	Inches per Second	LL	Live Load
IPT	Iron Pipe Threaded	LLD	Lamp Lumen Depreciation
ISP	Inlet Steam Pressure	LNG	Liquid Natural Gas
IW	Indirect Waste	LOA	Length Over All
		L-O-L	Lateraloleet
J	Joule	LP(G)	Liquid Propane (Gas)
JOB	Job	LS	Low Speed; Lump Sum
JOC	Job Order Contracting	Lt	Light
JT	Joint	Lt Ga	Light Gauge
		LTL	Less than Truck Load
K	Thousand; Thousand Pounds; Heavy Wall Copper Tubing; Kelvin	Lt Wt	Light Weight
KAH	Thousand Amp Hours	LV	Low Voltage
KD	Kiln Dried; Knocked Down	lm	Lumen
KDAT	Kiln Dried After Treatment	lm/sf	Lumen per square foot
Kip	1000 Pounds	lm/W	Lumen per Watt
KO	Knockout	m	Meter
Km	Kilometer	m <sup>3</sup> /H	Cubic Meters per Hour
KLF	Kips per Linear Foot	mA	Milliampere
KSF	Kips per Square Foot	m/S	Meters per Second
KSI	Kips per Square Inch	M	Thousand; Male; Light Wall Copper Tubing
kA	KiloAmp	MATL	Material
kg	Kilogram	MAX	Maximum
kHz	Kilohertz	Mach	Machine
kJ	Kilojoule	Mag. Str.	Magnetic Starter
kV	Kilovolt	Maint.	Maintenance
kVA	Kilovolt Ampere (1,000 volt amps)	Mat	Material
KVAR	Kilovar (Reactance)	Mat'l;	Material
kW	Kilowatt	Max.	Maximum
kWh	Kilowatt Hour	Mb	Million Bytes (characters)
		MBF	Thousand Board Feet
L	Length; Long; Medium Wall Copper Tubing	MBH	Thousand BTU per Hour
L&E	Labor and Equipment	MBtu	Thousand British Thermal Units
LAB	Labor	MC	Metal Clad Cable
LAN	Lane	MCF	Thousand Cubic Feet
LAT	Latitude	MCM	Thousand Circular Mills
LAV	Lavatory	MCP	Motor Circuit Protector
L.B.	Load Bearing; L Conduit Body	MD	Medium Duty
LB	Pound (Force or Mass)	MDO	Medium Density Overlaid
LB/HR	Pounds per Hour	Med.	Medium
LBS	Pounds	MF	Thousand Feet
LBSF	Pounds per Square Foot	MF3	Thousand Cubic Feet
LCD	Liquid Crystal Display	Mfg.	Manufacturing
LCL	Less Than Carload Lot	Mfrs.	Manufacturers
LCY	Loose Cubic Yard	Mg	Milligram



MG	Market Grade	nW	Nanowatt
MGD	Million Gallons per Day	OAL	Overall Length
MGPH	Thousand Gallons per Hour	OB	Opposing Blade
MH	Manhole; Manhour; Metal Halide	OC	On Center
MHz	MegaHertz	OD	Outside Diameter
Mi	Mile	O.D.	Outside Dimension
MI	Malleable Iron; Mineral Insulated	ODP	Open Drip Roof
MIN	Minimum; Minute	ODS	Overhead Distribution System
MISC	Miscellaneous	OEM	Original Equipment Manufacturer
ml	Milliliter; Mainline	OG	Ogee
MLF	Thousand Linear Feet	OH	Overhead
mm	Millimeter	OH&P	Overhead and Profit
MO	Month	OHL	Over Hung Load
Mobil.	Mobilization	Oper.	Operator
Mog.	Mogul Base	Opng.	Opening
MPH	Miles Per Hour	OPR	Operating
MPT	Male Pipe Thread	Orna.	Ornamental
MRT	Mile Round Trip	OSA	Outside Air
ms	Millisecond	OSB	Oriented Strand Board
MSD	Motor Sheave Diameter	OS & Y	Outside Screw and Yoke
MSF	Thousand Square Feet	OUT	Outlet or Output (each)
MSY	Thousand Square Yards	Ovhd.	Overhead
MT	Mount	OWG	Oil, Water or Gas
MTD	Mounted	OWSJ	Open Web Steel Joist
MTG	Mounting	OZ	Ounce
MTR	Mill Test Report	P	Pole; Applied Load; Projection
MVA	Million Volt Ampere	p	Page
MVAR	Million Volt Amperes Reactance	pp	Pages
MV	Megavolt	PAPR	Powered Air Purifying Respirator
MW	Megawatt	PAR	Weatherproof Reflector
MXM	Male by Male	PB	Push Button
MYD	Thousand Yards	PC	Personal Computer; Piece;
N	Natural; North	PCs	Pieces
nA	Nanoampere	P.C.	Portland Cement; Power Connector
NA	Not Applicable	PCF	Pounds per Cubic Foot
NC	Normally Closed	PCM	Phase Contrast Microscopy
NEHB	Bolted Circuit Breaker to 600V	PE	Professional Engineer; Plain End Porcelain Enamel; Polyethylene;
NDT	Non Destructive Testing	PERF	Perforated
NIOSH	National Alloy	PH	Phase
NLB	Non-Load Bearing	PI	Pressure Injected
NM	Non-Metallic Cable	PID	Programmable Integral Derivative Con- troller
nm	Nanometer	PKG	Package
NO	Normally Open	PL	Plate
No.	Number	PLC	Programmable Loop Controller
NOM	Nominal	PLM	Polarized Light Microscopy
NQOD	Combination Plug-on/Bolt-on Circuit Breaker to 240V	PLTC	Power Limited Tray Cable
NRC	Noise Reduction Coefficient	PLY	Plywood
NPT	National Pipe Thread	PNEU	Pneumatic
NPS	Nominal Pipe Size	PNTD	Painted
NRP	Non-Removable Pins	POA	Priced On Application/Priced On Approv- al
NRS	Non-Rising Stem	PESB	Pre-engineered Steel Building
ns	Nanosecond		
NTE	Note		
NTP	National Taper Pipe (Thread)		



PPD	Pounds Per Day	ROM	Room
PP; PPL	Polypropylene	ROPS	Roll Over Protection System
PPM	Parts Per Million	ROW	Row
PPS	Polyphenylene Sulfide	R.O.W.	Right of Way
PR	Pair	RPM	Revolutions Per Minute
Prefab.	Prefabricated	RR	Direct Burial Feeder Conduit
Prefin.	Prefinished	RS	Rapid Start
PROGEN®	Proposal Generator Software for Job Order Contracting	RSC	Rigid Steel Conduit
PROP	Propelled; Propeller	RSR	Riser (Per Rise)
PSF	Pounds Per Square Foot	RT	Round Trip
PSI	Pounds Per Square Inch	RTD	Resistance Temperature Detector
PSIA	Pounds Per Square Inch Atmosphere	RTJ	Ring Type Joint
PSIG	Pounds Per Square Inch Gauge	RTRP	Reinforced Thermoset Resin Piping
PSP	Plastic Sewer Pipe	RVT	Reinforced Vinyl Tile
PT	Power or Potential Transformer	S	Suction; Single Entrance; South
Pt.	Pint	S1S2E	Surfaced 1 side, 2 Edges
Ptns.	Partitions	S2S	Surfaced 2 Sides
P&T	Pressure & Temperature	S4S	Surfaced 4 Sides
PTFE	Polytetrafluoroethylene	Sa	Sack
Pu	Ultimate Load	SA	Supply Air
PV	Photovoltaic	SBS	Styrene Butyl Styrene
PVA	Polyvinyl Acrylate	Scaf.	Scaffolding
PVC	Polyvinyl Chloride	SCFH	Standard Cubic Foot Per Hour
PVDC	Polyvinylidene Chloride	SCFM	Standard Cubic Foot per Minute
PVDF	Polyvinylidene Fluoride	SCH	Schedule
PVF	Polyvinyl Fluoride	SCR	Modular Brick
Pvmt.	Pavement	SCRD	Screwed
PVQ	Pressure Vessel Quality	SD	Sound Deadening
Pwr.	Power	SDR	Standard Dimension Brick; Size To Diameter Ratio
Q	Quantity Heat Flow	SE	Surfaced Edge; Semi-Elliptical
QA	Quality Assurance	SEA	Seat
QC	Quality Control; Quick Coupling	SER	Service Entrance Cable
QT	Quart	SEU	Service Entrance Cable
Quan.	Quantity	SET	Set
Qty.	Quantity	SF	Square Foot/Feet
R	Thermal Resistance	SFCA	Square Feet of Form in Contact with Concrete
R/L	Random Lengths	SHTS	Sheets
R/W/L	Random Widths and Lengths	SI	Square Inch
RA	Return Air; Registered Architect	SIS	Synthetic Heat-Resistant
RCP	Reinforced Concrete Pipe	SLDR	Solder
Rect.	Rectangle	SLH	Super Long Span Bar Joist
REINF	Reinforced/Reinforcing	SN	Solid Neutral
Req'd	Required	S-O-L	Socketolet
RF	Raised Face	SP	Self-Propelled; Single Pole; Space; Standpipe Static Pressure (measured in inches of water);
RGH	Rough	SPDT	Single Pole, Double Throw
RGS	Rigid Galvanized Steel	SPGR	Specific Gravity
RH	Relative Humidity	SPWG	Static Pressure Water Gauge
RHW	Rubber, Heat & Water Resistant; Residential Hot Water	SQ	Square; Hundred Square Feet (10' x 10' area)
rms	Root Mean Square		
RND	Round		
ROL	Roll (each)		



SQ FT	Square Foot/Square Feet	UA	Unequal Angle
SQ IN	Square Inch	UCI	Uniform Construction Index
SQ YD	Square Yard	UF	Underground Feeder
SS	Stainless Steel; Single Strength	UHF	Ultra High Frequency
SSB	Single Strength B Quality Glass	UI	United Inch
SSL	Self Sealing Lap	UNC	Unified Coarse (Threads)
STC	Sound Transmission Class	USP	United States Primed
STD	Standard	UTP	Unshielded Twisted Pair
STK	Select Tight Knot	UV	Under Voltage
STP	Stop (each); Standard Temperature & Pressure	V	Volt
SURF	Surface	VA	Volt Amperes
STL	Steel	VAV	Variable Air Volume
SURF	Surface	VCT	Vinyl Composition Tile
SW	Seam Weld	Vert.	Vertical
SW	Switch	VF	Vinyl Faced
SWBD	Switchboard	VHF	Very High Frequency
SWS	Segmentally Welded Steel	VLF	Vertical Linear Foot
SWSI	Single Width, Single Inlet	VLV	Valve
SY	Square Yard	Vol.	Volume
SYN	Synthetic	VRP	Vinyl Reinforced Polyester
SYP	Southern Yellow Pine	w/	With
SYS	System	W	Watt; Width; Wire; West
T	Thick; Temperature; Ton	WB	Wet Bulb
T&C	Threaded and Coupled	WC	Water Column; Water Closet
T&G	Tongue and Groove	WF	Wide Flange
TBC	Tensile Bolt Cloth	WG	Water Gauge
TBE	Threaded Both Ends	WHM	Watthour Meter
TC	Terra Cotta	WK	Week
TCLP	Toxicity Characteristic Leaching Procedure	Wldg.	Welding
TDS	Total Dissolved Solids	WOG	Water, Oil, Gas
TEAO	Totally Enclosed Air Over	W-O-L	Weldolet
TEFC	Totally Enclosed Fan Cooled	WP	Weather Protected
TETC	Totally Enclosed Tube Cooled	WR	Water Resistant
TFE	Tetrafluoroethylene (Teflon)	WSP	Water, Steam, Petroleum
THHN	Nylon Jacketed Wire	WT	Weight
THK	Thick	WWF	Welded Wire Fabric
THKNS	Thickness	X or x	By or Times
THW	Insulated Strand Wire	XFER	Transfer
THWN	Nylon Jacketed Wire	XFMR	Transformer
TI	Titanium	XHD	Extra Heavy Duty
TL	Truckload	XHHW; XLPE	Cross-Linked Polyethylene Wire Insulation
TM	Track Mounted	XLP	Cross-Linked Polyethylene
T-O-L	Threadolet	XP	Explosion Proof
TON	Ton	XRF	X-Ray Fluorescence
Tot.	Total	Y	Wye
TPH	Tons Per Hour	YD	Yard
Transf.	Transformer	YR	Year
TSHP	Total Shaft Horse Power		
T'STAT	Thermostat		
TV	Television		
TW	Thermoplastic Water Resistant Wire		

## 2. Symbols



Δ	Delta	∅	Diameter or Phase
/	per	'	feet
-	through or to	"	inches
@	at	#	pound or number
%	per 100 or percent	°	degree
\$	U.S. dollars	<	Less Than
~	Approximate	>	Greater Than

3. Explanation Of Terms

BTU: Stands for British Thermal Unit. The BTU number indicates the amount of heat required to raise one pound of water by one degree Fahrenheit. What this means is the higher the BTU rating, the higher the heating capacity of a product.

MBH: Equal to 1000 BTUs.

Tons (In Reference To Cooling): Unit of measurement for determining cooling capacity. One ton equals 12,000 BTUH.

SEER: Stands for Seasonal Energy Efficiency Ratio. This measures the cooling efficiency in air conditioners or heat pumps. The higher the SEER rating, the more energy-efficient the unit. The government's minimum SEER rating is 10.

4. Calculation Of Board Feet

a. All Lumber Grades Are Presumed To Be 75 Percent Construction And 25 Percent Standard Or Equivalent Grade Unless Otherwise Listed. Dimensions Are Nominal. Board Foot Is Defined As 1" x 12" x 1' Long; To Calculate BF/LF, Multiply The Size Of The Board Height x Width/12.

- 1) 1"x2" = 0.167 BF/LF
- 2) 1"x3" = 0.25 BF/LF
- 3) 2"x3" = 0.5 BF/LF
- 4) 2"x4" = 0.667 BF/LF
- 5) 2"x6" = 1.0 BF/LF
- 6) 2"x8" = 1.333 BF/LF
- 7) 2"x10" = 1.667 BF/LF
- 8) 2"x12" = 2.0 BF/LF
- 9) 4"x4" = 1.333 BF/LF
- 10) 6"x4" = 2.0 BF/LF
- 11) 6"x6" = 3.0 BF/LF
- 12) 8"x8" = 5.333 BF/LF
- 13) etc.

b. To Calculate Board Feet;

- 1) For most lumber: Thickness (inches) x width (inches) x length (feet) divided by 12 = board feet.
- 2) For small pieces: Thickness (inches) x width (inches) x length (inches) divided by 144 = board feet.

5. Conversion Tables

ENGLISH TO METRIC CONVERSION TABLE					
MULTIPLY	BY	TO GET	MULTIPLY	BY	TO GET
acres	0.404 687 3	Hectares	ounce(force)	0.278 013 9	newtons=N
board foot	0.002 359 74	cubic meter	pint(liq.)	0.473 176	liters=l



ENGLISH TO METRIC CONVERSION TABLE					
cubic ft.	0.028 316 85	cubic meter	pint(dry)	0.550 61	liters=l
cubic yd.	0.764 554 9	cubic meter	pound(wt.)	0.453 592 37	kilogram
feet	0.304 8	Meters	pound(force)	4.448 222	newtons=N
footcandles	10.763 91	lux=lumens/m <sup>2</sup>	pound/sq.ft	47.880 26	pascal=N/m <sup>2</sup>
ft.-lb <sub>f</sub>	1.355 818	N□m=joule	pound/sq.in	6.894 757	kilopascals
gallon (US)	3.785 412	Liters	quart(liq.)	0.946 352 9	liters
horsepower <sup>*</sup>	745.699 9	watt=J/sec	sq. feet	0.092 903 04	sq. meter
* horsepower=550 ft-lb <sub>f</sub> /sec			sq. in.	645.16	sq. mm
inch	25.4	Millimeters	sq. mile	258.998 8	hectares
inch-pound <sub>f</sub>	0.112 984 8	N□m=joule	sq. mile	2.589 988	sq. km
kips	4.448 222	Kilonewton	sq. yard	0.836 127 4	sq. meter
kips/in <sup>2</sup>	6.894 757	megapascal	ton(short)	0.907 184 7	metric ton
miles (US)	1.609 347	Kilometer	ton(short)	907.184 7	kilogram=kg
ounce (wt.)	28.349 52	Grams	ton(short)	8896.444	newtons=N
ounce(liq.)	29.573 53	MI	yards	0.914 4	meters=m

**FOR TEMPERATURE CONVERSION USE °C= 5/9(°F - 32)**



METRIC TO ENGLISH CONVERSION TABLE					
MULTIPLY	BY	TO GET	MULTIPLY	BY	TO GET
<b>cubic meter</b>	1.308 0	cubic yard	<b>liter</b>	0.264 17	gallon
	35.314 7	cubic foot		1.056 7	quart
	61,024	cubic inch		2.113 4	pint
	264.172	Gallon		33.814	fl.ounce
<b>gram</b>	0.035 274	ounce(wt)	milliliter	0.033 814	fl.ounce
	0.002 204 6	pound(wt)	liter/m	0.080 52	gal/ft
kilogram	35.274	ounce(wt)	liter/m <sup>2</sup>	0.220 88	gal/sq.yd
	2.204 623	pound(wt)	<b>lux</b>	0.092 902	ft-candle
	0.002 204 6	Kip	<b>meter</b>	1.093 6	yard
	0.001 102 3	Ton		3.280 84	foot
megagram (metric ton)	1.102 3	ton	millimeter	0.039 370	inch
			kilometer	0.621 37	mile
<b>hectare</b>	2.471 04	Acre	micrometer	0.039 370 1	mil
	107,639	square feet	<b>Newton</b>	0.224 81	pound(f)
	11,959.9	square yard	kilonewton	0.224 81	kip(f)
	0.003 861 02	square mile	<b>Pascal</b>	0.020 885	lb/sq. feet
microare	0.155 00	square inch	kilopascal	0.145 04	lb/sq. inch
<b>joule</b>	0.737 56	foot pound	megapascal	0.145 04	kips/sq. inch
	8.849 5	inch pound	<b>square meter</b>	1.195 99	square yard
<b>kg/m<sup>3</sup></b>	1.685 55	lbs./cubic yards		10.763 9	square feet
	0.062 428	lbs./cubic feet	square millimeter	0.001 55	square inch
<b>km/hr</b>	0.621 37	miles per hour	square kilometer	0.386 102	square mile
			<b>watt (J/second)</b>	0.001 341	horsepower
				0.737 56	ft-lb/second

FOR TEMPERATURE CONVERSION USE °F = 9/5 °C + 32



C. Material Weights/Engineering Values

1. The following engineering values are guidelines for establishing shrink/swell factors and shall be used unless otherwise directed by the Owner. The Owner has final authority in establishing unit weights that are appropriate for all material and may change the stated values.

a. Material weights (Lbs Per CY) for In-place (Bank) [BCY], Loose (Excavated Materials) [LCY], and Compacted [CCY]

<u>MATERIALS</u>	<u>BCY</u>	<u>LCY</u>	<u>CCY</u>
Earth, Common (Average)	3170	2536	3520
Sand (Dry)	2880	2590	3240
Sand (Wet)	3090	2940	3460
Earth, Dry	3030	2070	3520
Earth, Damp	3370	2360	3520
Earth, Wet	2940	2940	3520
Earth, Rock Mixture (75% E/ 25% R)	3380	2370	3720
Earth, Rock Mixture (50% E/ 50% R)	3750	2710	4000
Earth, Rock Mixture (25% E/ 75% R)	4120	3140	3680
Gravel (Average)	3280	2730	3570
Limestone	4380	2690	3220
Riprap Rock (Average)	4500	2610	3150
Granite	4540	2640	3170
Basalt	4950	3020	3640
Clay	3220	2150	3570
Gneiss	4550	2720	3180

D. Reclaimed Asphalt Pavement (RAP)

1. Origin

a. Reclaimed asphalt pavement (RAP) is the term given to removed and/or reprocessed pavement materials containing asphalt and aggregates. These materials are generated when asphalt pavements are removed for reconstruction, resurfacing, or to obtain access to buried utilities. When properly crushed and screened, RAP consists of high-quality, well-graded aggregates coated by asphalt cement.

b. Asphalt pavement is generally removed either by milling or full-depth removal. Milling entails removal of the pavement surface using a milling machine, which can remove up to 50 mm (2 in) thickness in a single pass. Full-depth removal involves ripping and breaking the pavement using a rhino horn on a bulldozer and/or pneumatic pavement breakers. In most instances, the broken material is picked up and loaded into haul trucks by a front-end loader and transported to a central facility for processing. At this facility, the RAP is processed using a series of operations, including crushing, screening, conveying, and stacking.

c. Although the majority of old asphalt pavements are recycled at central processing plants, asphalt pavements may be pulverized in place and incorporated into granular or stabilized base courses using a self-propelled pulverizing machine. Hot in-place and cold in-place recycling processes have evolved into continuous train operations that include partial depth removal of the pavement surface, mixing the reclaimed material with beneficiating additives (such as virgin aggregate, binder, and/or softening or rejuvenating agents to improve binder properties), and placing and compacting the resultant mix in a single pass.

2. Physical Properties

a. The properties of RAP are largely dependent on the properties of the constituent materials and the type of asphalt concrete mix (wearing surface, binder course, etc.). There can be substantial differences between asphalt concrete mixes in aggregate quality, size, and consistency. Since the aggregates in surface course (wearing course) asphalt concrete must have high resistance to wear/abrasion (polishing) to contribute to acceptable friction



- resistance properties, these aggregates may be of higher quality than the aggregates in binder course applications, where polishing resistance is not of concern.
- b. Both milling and crushing can cause some aggregate degradation. The gradation of milled RAP is generally finer and more dense than that of the virgin aggregates. Crushing does not cause as much degradation as milling; consequently, the gradation of crushed RAP is generally not as fine as milled RAP, but finer than virgin aggregates crushed with the same type of equipment.
  - c. The particle size distribution of milled or crushed RAP may vary to some extent, depending on the type of equipment used to produce the RAP, the type of aggregate in the pavement, and whether any underlying base or subbase aggregate has been mixed in with the reclaimed asphalt pavement material during the pavement removal.
  - d. During processing, virtually all RAP produced is milled or crushed down to 38 mm (1.5 in) or less, with a maximum allowable top size of either 51 mm (2 in) or 63 mm (2.5 in). Table 13-1 lists the typical range of particle size distribution that normally results from the milling or crushing of RAP. Milled RAP is generally finer than crushed RAP. The pavement fraction passing a 2.36 mm (No. 8) sieve can be expected to increase from a premilled range of 41 to 69 percent to a postmilled range of 52 to 72 percent. The fraction passing a 0.075 mm (No. 200) sieve can be expected to increase from approximately 6 to 10 percent to a range of 8 to 12 percent. Most sources of RAP will be a well-graded coarse aggregate, comparable to, or perhaps slightly finer and more variable than, crushed natural aggregates.
  - e. The unit weight of milled or processed RAP depends on the type of aggregate in the reclaimed pavement and the moisture content of the stockpiled material. The unit weight of milled or processed RAP has been found to range from 1940 to 2300 kg/m<sup>3</sup> (120 to 140 lb/ft<sup>3</sup>), which is slightly lower than that of natural aggregates.
  - f. Moisture content of the RAP will increase while in storage. Crushed or milled RAP can pick up a considerable amount of water if exposed to rain. Moisture contents up to 5 percent or higher have been measured for stored crushed RAP. As noted earlier, during periods of extensive precipitation, the moisture content of some RAP stockpiles may be as high as 7 to 8 percent. Lengthy stockpiling of crushed or milled RAP should, therefore, be kept to a minimum.
  - g. The asphalt cement content of RAP typically ranges between 3 and 7 percent by weight. The asphalt cement adhering to the aggregate is somewhat harder than new asphalt cement. This is due primarily to exposure of the pavement to atmospheric oxygen (oxidation) during use and weathering. The degree of hardening depends on several factors, including the intrinsic properties of the asphalt cement, the mixing temperature/time (increases with increasing high temperature exposure), the degree of asphalt concrete compaction (increases if not well compacted), asphalt cement/air voids content (increases with lower asphalt/higher air voids content), and age in service (increases with age).



**Table 1. Typical range of particle size distribution for reclaimed asphalt pavement (RAP) (percent by weight passing).**

Screen Size (mesh)	Percent Finer After Processing or Milling
37.5 mm (1.5 in)	100
25 mm (1.0 in)	95 - 100
19 mm (3/4 in)	84 - 100
12.5 mm (1/2 in)	70 - 100
9.5 mm (3/8 in)	58 - 95
75 mm (No. 4)	38 - 75
2.36 mm (No. 8)	25 - 60
1.18 mm (No. 16)	17 - 40
0.60 mm (No. 30)	10 - 35 <sup>a</sup>
0.30 mm (No. 50)	5 - 25 <sup>b</sup>
0.15 mm (No. 100)	3 - 20 <sup>c</sup>
0.075 mm (No. 200)	2 - 15 <sup>d</sup>
a. Usually less than 30 percent b. Usually less than 20 percent c. Usually less than 15 percent d. Usually less than 10 percent	

- h. The RAP obtained from most wearing surface mixes will usually have an asphalt content in the 4.5 to 6 percent range. The recovered asphalt from RAP usually exhibits low penetration and relatively high viscosity values, depending on the amount of time the original pavement has been in service. Penetration values at 25°C (77°F) are likely to range from 10 to 80 while the absolute viscosity values at 60°C (140°F) may range from as low as 2,000 poises (equivalent to AC-20) up to as high as 50,000 poises or greater, depending on the extent of aging. Viscosity ranges from 4,000 to 25,000 poises can normally be expected from the asphalt cement that is recovered from RAP material. Table 2 provides a summary of the typical ranges of physical properties of RAP, other than gradation.

**Table 2. Physical and mechanical properties of reclaimed asphalt pavement (RAP).**

Type of Property	RAP Property	Typical Range of Values
Physical Properties	Unit Weight	1940 - 2300 kg/m <sup>3</sup> (120-140 lb/ft <sup>3</sup> )
	Moisture Content	Normal: up to 5% Maximum: 7-8%
	Asphalt Content	Normal: 4.5-6% Maximum Range: 3-7%
	Asphalt Penetration	Normal: 10-80 at 25°C (77°F)
	Absolute Viscosity or Recovered Asphalt Cement	Normal: 4,000 - 25,000 poises at 60°C (140°F)
Mechanical Properties	Compacted Unit Weight	1600 - 2000 kg/m <sup>3</sup> (100-125 lb/ft <sup>3</sup> )
	California Bearing Ratio (CBR)	100% RAP: 20-25% 40% RAP and 60% Natural Aggregate: 150% or higher

### 3. Chemical Properties

- a. Mineral aggregates constitute the overwhelming majority (93 to 97 percent by weight) of RAP. Only a minor percentage (3 to 7 percent) of RAP consists of hardened asphalt cement. Consequently, the overall chemical composition of RAP is essentially similar to that of the naturally occurring aggregate that is its principal constituent.
- b. Asphalt cement is made up of mainly high molecular weight aliphatic hydrocarbon compounds, but also small concentrations of other materials such as sulfur, nitrogen, and polycyclic hydrocarbons (aromatic and/or naphthenic) of very low chemical reactivity. Asphalt cement is a combination of asphaltenes and maltenes (resins and oils). Asphaltenes are more viscous than either resins or oils and play a major role in determining asphalt viscosity. Oxidation of aged asphalt causes the oils to convert to resins and the resins to convert to asphaltenes, resulting in age hardening and a higher viscosity binder.

### 4. Mechanical Properties

- a. The mechanical properties of RAP depend on the original asphalt pavement type, the method(s) utilized to recover the material, and the degree of processing necessary to prepare the RAP for a particular application. Since most RAP is recycled back into pavements, there is a general lack of data pertaining to the mechanical properties for RAP in other possible applications.
- b. The compacted unit weight of RAP will decrease with increasing unit weight, with maximum dry density values reported to range from 1600 kg/m<sup>3</sup> (100 lb/ft<sup>3</sup>) to 2000 kg/m<sup>3</sup> (125 lb/ft<sup>3</sup>). California Bearing Ratio (CBR) values for RAP material containing trap rock aggregate have been reported in the 20 to 25 percent range. However, when RAP is blended with natural aggregates for use in granular base, the asphalt cement in the RAP has a significant strengthening effect over time, such that specimens containing 40 percent RAP have produced CBR values exceeding 150 after 1 week.
- c. Table 2 provides a summary of the mechanical properties of RAP discussed in the preceding paragraphs.

## 1.2 PRODUCTS (Not Used)



1.3 EXECUTION (Not Used)

END OF SECTION 01 32 33 00d



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**SECTION 01 51 13 00 - PANELBOARDS**

## 1.1 GENERAL

## A. Description Of Work

1. This specification covers the furnishing and installation of materials for panelboards. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Distribution panelboards.
  - b. Lighting and appliance branch-circuit panelboards.
  - c. Load centers.
  - d. Electronic-grade panelboards.

## C. Definitions

1. SVR: Suppressed voltage rating.
2. TVSS: Transient voltage surge suppressor.

## D. Performance Requirements

1. Seismic Performance: Panelboards 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 each panelboard and related equipment.
  - a. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
  - b. Detail enclosure types and details for types other than NEMA 250, Type 1.
  - c. Detail bus configuration, current, and voltage ratings.
  - d. Short-circuit current rating of panelboards and overcurrent protective devices.
  - e. Include evidence of NRTL listing for series rating of installed devices.
  - f. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - g. Include wiring diagrams for power, signal, and control wiring.
  - h. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
3. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
4. Panelboard Schedules: For installation in panelboards.
5. 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 NEMA PB 1.
3. Comply with NFPA 70.



- G. Delivery, Storage, And Handling
1. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
  2. Handle and prepare panelboards for installation according to NECA 407 **OR** NEMA PB 1.
- H. Project Conditions
1. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
    - a. Notify the Owner no fewer than two days in advance of proposed interruption of electric service.
    - b. Do not proceed with interruption of electric service without the Owner's written permission.
    - c. Comply with NFPA 70E.
- I. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within five years from date of Final Completion.

## 1.2 PRODUCTS

- A. General Requirements For Panelboards
1. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
  2. Enclosures: Flush **OR** Surface **OR** Flush- and surface, **as directed**,-mounted cabinets.
    - a. Rated for environmental conditions at installed location.
      - 1) Indoor Dry and Clean Locations: NEMA 250, Type 1.
      - 2) Outdoor Locations: NEMA 250, Type 3R.
      - 3) Kitchen or Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
      - 4) Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
      - 5) Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5 **OR** Type 12, **as directed**.
    - b. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
    - c. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
    - d. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
    - e. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
    - f. Finishes:
      - 1) Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
      - 2) Back Boxes: Galvanized steel **OR** Same finish as panels and trim, **as directed**.
      - 3) Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
    - g. Directory Card: Inside panelboard door, mounted in transparent card holder **OR** metal frame with transparent protective cover, **as directed**.
  3. Incoming Mains Location: Top **OR** Bottom **OR** Top and bottom, **as directed**.
  4. Phase, Neutral, and Ground Buses:
    - a. Material: Tin-plated aluminum **OR** Hard-drawn copper, 98 percent conductivity, **as directed**.



- b. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
  - c. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
  - d. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
  - e. Split Bus: Vertical buses divided into individual vertical sections.
  5. Conductor Connectors: Suitable for use with conductor material and sizes.
    - a. Material: Tin-plated aluminum **OR** Hard-drawn copper, 98 percent conductivity, **as directed**.
    - b. Main and Neutral Lugs: Compression **OR** Mechanical, **as directed**, type.
    - c. Ground Lugs and Bus-Configured Terminators: Compression **OR** Mechanical, **as directed**, type.
    - d. Feed-Through Lugs: Compression **OR** Mechanical, **as directed**, type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
    - e. Subfeed (Double) Lugs: Compression **OR** Mechanical, **as directed**, type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
    - f. Gutter-Tap Lugs: Compression **OR** Mechanical, **as directed**, type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
    - g. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
  6. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
  7. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
  8. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.
  9. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.
- B. Distribution Panelboards
1. Panelboards: NEMA PB 1, power and feeder distribution type.
  2. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
    - a. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.
  3. Mains: Circuit breaker **OR** Fused switch **OR** Lugs only, **as directed**.
  4. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in **OR** Bolt-on, **as directed**, circuit breakers.
  5. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
  6. Branch Overcurrent Protective Devices: Fused switches.
  7. Contactors in Main Bus: NEMA ICS 2, Class A, electrically **OR** mechanically, **as directed**, held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
    - a. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
    - b. External Control-Power Source: 120-V branch circuit **OR** 24-V control circuit, **as directed**.
- C. Lighting And Appliance Branch-Circuit Panelboards
1. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
  2. Mains: Circuit breaker **OR** Lugs only, **as directed**.
  3. Branch Overcurrent Protective Devices: Plug-in **OR** Bolt-on, **as directed**, circuit breakers, replaceable without disturbing adjacent units.
  4. Contactors in Main Bus: NEMA ICS 2, Class A, electrically **OR** mechanically, **as directed**, held, general-purpose controller, with same short-circuit interrupting rating as panelboard.



- a. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
- b. External Control-Power Source: 120-V branch circuit **OR** 24-V control circuit, **as directed**.
5. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
6. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

#### D. Load Centers

1. Load Centers: Comply with UL 67.
2. Mains: Circuit breaker **OR** Lugs only, **as directed**.
3. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
4. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

#### E. Electronic-Grade Panelboards

1. Panelboards: NEMA PB 1; with factory-installed, integral TVSS; labeled by an NRTL for compliance with UL 67 after installing TVSS.
2. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
3. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
4. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
5. Buses:
  - a. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
  - b. Copper equipment and isolated ground buses.
6. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, plug-in **OR** wired-in **OR** bolt-on, **as directed**, solid-state, parallel-connected, modular (with field-replaceable modules) **OR** non-modular, **as directed**, type, with sine-wave tracking suppression and filtering modules, short-circuit current rating complying with UL 1449, second edition, and matching or exceeding the panelboard short-circuit rating, redundant suppression circuits, with individually fused metal-oxide varistors.
  - a. Accessories:
    - 1) Fuses rated at 200-kA interrupting capacity.
    - 2) Fabrication using bolted compression lugs for internal wiring.
    - 3) Integral disconnect switch.
    - 4) Redundant suppression circuits.
    - 5) Redundant replaceable modules.
    - 6) Arrangement with wire connections to phase buses, neutral bus, and ground bus.
    - 7) LED indicator lights for power and protection status.
    - 8) Audible alarm, with silencing switch, to indicate when protection has failed.
    - 9) Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
    - 10) Four **OR** Six, **as directed**,-digit, transient-event counter set to totalize transient surges.
  - b. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase **OR** 120 kA per mode/240 kA per phase **OR** 80 kA per mode/160 kA per phase, **as directed**.
  - c. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.
    - 1) Line to Neutral: 70,000 A.
    - 2) Line to Ground: 70,000 A.
    - 3) Neutral to Ground: 50,000 A.
  - d. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
  - e. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 **OR** 208Y/120 **OR** 600Y/347, **as directed**,-V, three-phase, four-wire circuits shall be as follows:



- 1) Line to Neutral: 800 V for 480Y/277 **OR** 400 V for 208Y/120 **OR** 1200 V for 600Y/347, **as directed**.
  - 2) Line to Ground: 800 V for 480Y/277 **OR** 400 V for 208Y/120 **OR** 1200 V for 600Y/347, **as directed**.
  - 3) Neutral to Ground: 800 V for 480Y/277 **OR** 400 V for 208Y/120 **OR** 1200 V for 600Y/347, **as directed**.
- f. Protection modes and UL 1449 SVR for 240/120-V, single-phase, three-wire circuits shall be as follows:
- 1) Line to Neutral: 400 V.
  - 2) Line to Ground: 400 V.
  - 3) Neutral to Ground: 400 V.
- g. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:
- 1) Line to Neutral: 400 V, 800 V from high leg.
  - 2) Line to Ground: 400 V.
  - 3) Neutral to Ground: 400 V.
- h. Protection modes and UL 1449 SVR for 240-, 480-, or 600-V, three-phase, three-wire, delta circuits shall be as follows:
- 1) Line to Line: 2000 V for 480 V **OR** 1000 V for 240 V **OR** 2500 V for 600 V, **as directed**.
  - 2) Line to Ground: 1500 V for 480 V **OR** 800 V for 240 V **OR** 2500 V for 600 V, **as directed**.
- F. Disconnecting And Overcurrent Protective Devices
1. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating **OR** interrupting capacity, **as directed**, to meet available fault currents.
    - a. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    - b. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
    - c. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
      - 1) Instantaneous trip.
      - 2) Long- and short-time pickup levels.
      - 3) Long- and short-time time adjustments.
      - 4) Ground-fault pickup level, time delay, and  $I^2t$  response.
    - d. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
    - e. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
    - f. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
    - g. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
    - h. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
      - 1) Standard frame sizes, trip ratings, and number of poles.
      - 2) Lugs: Compression **OR** Mechanical, **as directed**, style, suitable for number, size, trip ratings, and conductor materials.
      - 3) Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
      - 4) Ground-Fault Protection: Integrally mounted **OR** Remote-mounted, **as directed**, relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.



- 5) Communication Capability: Circuit-breaker-mounted **OR** Universal-mounted **OR** Integral **OR** Din-rail-mounted, **as directed**, communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring And Control".
  - 6) Shunt Trip: 120 **OR** 24, **as directed**, -V trip coil energized from separate circuit, set to trip at 55 **OR** 75, **as directed**, percent of rated voltage.
  - 7) Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional **OR** with field-adjustable 0.1- to 0.6-second, **as directed**, time delay.
  - 8) Auxiliary Contacts: One SPDT switch **OR** Two SPDT switches, **as directed**, with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
  - 9) Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
  - 10) Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
  - 11) Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
  - 12) Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
  - 13) Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on **OR** off, **as directed**, position.
  - 14) Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
2. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- a. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses".
  - b. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
  - c. Auxiliary Contacts: One **OR** Two, **as directed**, normally open and normally closed contact(s) that operate with switch handle operation.

#### G. Panelboard Suppressors

1. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
  - a. Accessories:
    - 1) LED indicator lights for power and protection status.
    - 2) Audible alarm, with silencing switch, to indicate when protection has failed.
    - 3) One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
2. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, plug-in **OR** wired-in **OR** bolt-on, **as directed**, solid-state, parallel-connected, modular (with field-replaceable modules) **OR** non-modular, **as directed**, type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
  - a. Accessories:
    - 1) Fuses rated at 200-kA interrupting capacity.
    - 2) Fabrication using bolted compression lugs for internal wiring.
    - 3) Integral disconnect switch.
    - 4) Redundant suppression circuits.
    - 5) Redundant replaceable modules.
    - 6) Arrangement with wire connections to phase buses, neutral bus, and ground bus.
    - 7) LED indicator lights for power and protection status.
    - 8) Audible alarm, with silencing switch, to indicate when protection has failed.
    - 9) Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position



- on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
- 10) Four **OR** Six, **as directed**, -digit, transient-event counter set to totalize transient surges.
  - b. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase **OR** 120 kA per mode/240 kA per phase **OR** 80 kA per mode/160 kA per phase, **as directed**.
  - c. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.
    - 1) Line to Neutral: 70,000 A.
    - 2) Line to Ground: 70,000 A.
    - 3) Neutral to Ground: 50,000 A.
  - d. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
  - e. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 **OR** 208Y/120 **OR** 600Y/347, **as directed**, -V, three-phase, four-wire circuits shall be as follows:
    - 1) Line to Neutral: 800 V for 480Y/277 **OR** 400 V for 208Y/120 **OR** 1200 V for 600Y/347, **as directed**.
    - 2) Line to Ground: 800 V for 480Y/277 **OR** 400 V for 208Y/120 **OR** 1200 V for 600Y/347, **as directed**.
    - 3) Neutral to Ground: 800 V for 480Y/277 **OR** 400 V for 208Y/120 **OR** 1200 V for 600Y/347, **as directed**.
  - f. Protection modes and UL 1449 SVR for 240/120-V, single-phase, three-wire circuits shall be as follows:
    - 1) Line to Neutral: 400 V.
    - 2) Line to Ground: 400 V.
    - 3) Neutral to Ground: 400 V.
  - g. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:
    - 1) Line to Neutral: 400 V, 800 V from high leg.
    - 2) Line to Ground: 400 V.
    - 3) Neutral to Ground: 400 V.
  - h. Protection modes and UL 1449 SVR for 240-, 480-, or 600-V, three-phase, three-wire, delta circuits shall be as follows:
    - 1) Line to Line: 2000 V for 480 V **OR** 1000 V for 240 V **OR** 2500 V for 600 V, **as directed**.
    - 2) Line to Ground: 1500 V for 480 V **OR** 800 V for 240 V **OR** 2500 V for 600 V, **as directed**.
- H. Accessory Components And Features
1. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
  2. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

### 1.3 EXECUTION

#### A. Installation

1. Install panelboards and accessories according to NECA 407 **OR** NEMA PB 1.1, **as directed**.
2. Equipment Mounting: Install panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
  - a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.



- b. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
- c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- d. Install anchor bolts to elevations required for proper attachment to panelboards.
- e. Attach panelboard to the vertical finished or structural surface behind the panelboard.
3. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
4. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers And Supports For Electrical Systems".
5. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
6. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
7. Install overcurrent protective devices and controllers not already factory installed.
  - a. Set field-adjustable, circuit-breaker trip ranges.
8. Install filler plates in unused spaces.
9. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
10. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing, **as directed**.
11. Comply with NECA 1.

#### B. Identification

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification For Electrical Systems".
2. Create a directory to indicate installed circuit loads after balancing panelboard loads, **as directed**; incorporate the Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
3. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".
4. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".

#### C. Field Quality Control

1. Perform tests and inspections.
2. Acceptance Testing Preparation:
  - a. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - b. Test continuity of each circuit.
3. Tests and Inspections:
  - a. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - b. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - c. Perform the following infrared scan tests and inspections and prepare reports:
    - 1) Initial Infrared Scanning: After Final Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    - 2) Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Final Completion.
    - 3) Instruments and Equipment:



- a) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  4. Panelboards will be considered defective if they do not pass tests and inspections.
  5. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- D. Adjusting
1. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
  2. Set field-adjustable circuit-breaker trip ranges as indicated **OR** as specified in Division 26 Section "Overcurrent Protective Device Coordination Study", **as directed**.
  3. Load Balancing: After Final Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
    - a. Measure as directed during period of normal system loading.
    - b. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
    - c. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
    - d. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.
- E. Protection
1. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 01 51 13 00



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



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## SECTION 01 54 23 00 - SCAFFOLDING TUBULAR STEEL

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Submittals

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

### 1.2 PRODUCTS

- A. Tubular steel or aluminum scaffolding system shall comply with OSHA Safety and Health Standards, Section 29 CFR, 1926/1910.

### 1.3 EXECUTION - (Section not used.)

END OF SECTION 01 54 23 00



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**SECTION 01 54 23 00a - UNIT MASONRY ASSEMBLIES**

## 1.1 GENERAL

## A. Description Of Work

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

## B. Summary

1. This Section includes unit masonry assemblies consisting of the following:
  - a. Concrete masonry units (CMUs).
  - b. Decorative concrete masonry units.
  - c. Pre-faced concrete masonry units.
  - d. Concrete brick.
  - e. Face brick.
  - f. Building (common) brick.
  - g. Hollow brick.
  - h. Glazed brick.
  - i. Structural-clay facing tile.
  - j. Firebox brick.
  - k. Clay flue lining units.
  - l. Stone trim units.
  - m. Mortar and grout.
  - n. Reinforcing steel.
  - o. Masonry joint reinforcement.
  - p. Ties and anchors.
  - q. Embedded flashing.
  - r. Miscellaneous masonry accessories.
  - s. Masonry-cell insulation.
  - t. Cavity-wall insulation.

## C. Definitions

1. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

## D. Performance Requirements

1. Provide structural unit masonry that develops indicated net-area compressive strengths ( $f'_m$ ) at 28 days.
2. Determine net-area compressive strength ( $f'_m$ ) of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602 **OR** Tables 2105.2 in the International Building Code, **as directed.**  
**OR**  
Determine net-area compressive strength ( $f'_m$ ) of masonry by testing masonry prisms according to ASTM C 1314 **OR** IBC Standard, **as directed.**

## E. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: For reinforcing steel. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
3. Samples for each type and color of exposed masonry units and colored mortars.



4. Material Certificates: For each type of product indicated. Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards.
5. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
  - a. For masonry units include material test reports substantiating compliance with requirements.
6. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

#### F. Quality Assurance

1. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing indicated below.
  - a. Clay Masonry Unit Test: For each type of unit required, per ASTM C 67.
  - b. Concrete Masonry Unit Test: For each type of unit required, per ASTM C 140.
  - c. Mortar Test (Property Specification): For each mix required, per ASTM C 780 **OR** IBC Standard, **as directed**.
  - d. Grout Test (Compressive Strength): For each mix required, per ASTM C 1019 **OR** IBC Standard, **as directed**.
2. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.
3. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects.
  - a. Build sample panels for each type of exposed unit masonry construction **OR** typical exterior wall, **as directed**, in sizes approximately 48 inches (1200 mm) long by 48 inches (1200 mm) high.

#### G. Delivery, Storage, And Handling

1. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
2. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
3. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
4. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
5. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

#### H. Project Conditions

1. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602 **OR** Section 2104.3 in the International Building Code, **as directed**.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.



## 1.2 PRODUCTS

### A. Concrete Masonry Units (CMUs)

1. Shapes: Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Integral Water Repellent: Provide units made with liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength for exposed units and where indicated.
3. Concrete Masonry Units: ASTM C 90 **OR** IBC Standard, **as directed**.
  - a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi (13.1 MPa) **OR** 2150 psi (14.8 MPa) **OR** 2800 psi (19.3 MPa) **OR** 3050 psi (21.0 MPa), **as directed**.
  - b. Weight Classification: Lightweight **OR** Medium weight **OR** Normal weight, **as directed**.
4. Decorative Concrete Masonry Units: ASTM C 90 **OR** IBC Standard, **as directed**.
  - a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi (13.1 MPa) **OR** 2150 psi (14.8 MPa) **OR** 2800 psi (19.3 MPa) **OR** 3050 psi (21.0 MPa), **as directed**.
  - b. Weight Classification: Lightweight **OR** Medium weight **OR** Normal weight, **as directed**.
  - c. Pattern and Texture:
    - 1) Standard pattern, ground finish.
    - 2) Standard pattern, split-face finish.
    - 3) Standard pattern, split-ribbed finish.
    - 4) Scored vertically, standard finish.
    - 5) Triple scored vertically, standard finish.
5. Pre-faced Concrete Masonry Units: Lightweight hollow **OR** solid, **as directed**, concrete units complying with ASTM C 90 **OR** IBC Standard, **as directed**, with manufacturer's standard smooth resinous facing complying with ASTM C 744.
  - a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi (13.1 MPa) **OR** 2150 psi (14.8 MPa) **OR** 2800 psi (19.3 MPa) **OR** 3050 psi (21.0 MPa), **as directed**.
  - b. Size: Manufactured with pre-faced surfaces having 1/16-inch- (1.5-mm-) wide returns of facing to create 1/4-inch- (6.5-mm-) wide mortar joints with modular coursing.
6. Concrete Building Brick: ASTM C 55 **OR** IBC Standard, **as directed**.
  - a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2500 psi (17.3 MPa) **OR** 3500 psi (24.1 MPa), **as directed**.
  - b. Weight Classification: Lightweight **OR** Medium weight **OR** Normal weight, **as directed**.

### B. Concrete And Masonry Lintels

1. General: Provide either concrete or masonry lintels, at Contractor's option, complying with requirements below.
2. Concrete Lintels:
  - a. Precast units matching concrete masonry units and with reinforcing bars indicated or required to support loads indicated.  
**OR**  
Precast or formed-in-place concrete lintels complying with requirements in Division 03 Section "Cast-in-place Concrete".
3. Masonry Lintels: Made from bond beam concrete masonry units with reinforcing bars placed as indicated and filled with coarse grout.

### C. Brick

1. General: Provide shapes indicated and as follows:
  - a. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
  - b. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.



2. Face Brick: ASTM C 216 **OR** IBC Standard, **as directed**, Grade SW **OR** MW or SW, **as directed**, Type FBX **OR** FBS **OR** FBA, **as directed**.
  - a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi (20.7 MPa) **OR** 4400 psi (30.3 MPa) **OR** 5500 psi (37.9 MPa) **OR** 6400 psi (44.1 MPa) **OR** 8000 psi (55.2 MPa) **OR** 8400 psi (57.9 MPa), **as directed**.
  - b. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67.
  - c. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
  - d. Surface Coating: Brick with colors or textures produced by application of coatings shall withstand 50 cycles of freezing and thawing per ASTM C 67 with no observable difference in the applied finish when viewed from 10 feet (3 m).
  - e. Size: **As directed**.
3. Building (Common) Brick: ASTM C 62 **OR** IBC Standard, **as directed**, Grade SW **OR** MW or SW **OR** NW, MW, or SW, **as directed**.
  - a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi (20.7 MPa) **OR** 4400 psi (30.3 MPa) **OR** 5500 psi (37.9 MPa) **OR** 6400 psi (44.1 MPa) **OR** 8000 psi (55.2 MPa) **OR** 8400 psi (57.9 MPa), **as directed**.
  - b. Size: Match size of face brick.
4. Hollow Brick: ASTM C 652 **OR** IBC Standard, **as directed**, Grade SW **OR** MW or SW, **as directed**, Class H40V (void areas between 25 and 40 percent of gross cross-sectional area) **OR** H60V (void areas between 40 and 60 percent of gross cross-sectional area) , **as directed**, Type HBX **OR** HBS **OR** HBA **OR** HBB, **as directed**.
  - a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi (20.7 MPa) **OR** 4400 psi (30.3 MPa) **OR** 5500 psi (37.9 MPa) **OR** 6400 psi (44.1 MPa) **OR** 8000 psi (55.2 MPa) **OR** 8400 psi (57.9 MPa), **as directed**.
  - b. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
  - c. Surface Coating: Brick with colors or textures produced by application of coatings shall withstand 50 cycles of freezing and thawing per ASTM C 67 with no observable difference in the applied finish when viewed from 10 feet (3 m).
  - d. Size: **As directed**.
5. Glazed Face Brick: ASTM C 216 **OR** IBC Standard, **as directed**, Grade SW **OR** MW or SW, **as directed**, Type FBX **OR** FBS **OR** FBA, **as directed**; with glaze complying with ASTM C 126.
6. Glazed Face Brick: ASTM C 1405, Class Exterior **OR** Interior, **as directed**, Grade S (Select) **OR** SS (Select Sized or Ground Edge), **as directed**.
7. Glazed Face Brick: Either ASTM C 1405, Class Exterior **OR** Interior, **as directed**, Grade S (Select) or ASTM C 216 **OR** IBC Standard, **as directed**, Grade SW **OR** MW or SW, **as directed**, Type FBX; with glaze complying with ASTM C 126.
8. Glazed Hollow Brick: Hollow brick complying with ASTM C 652 **OR** IBC , **as directed**, Grade SW **OR** MW or SW, **as directed**, Class H40V (void areas between 25 and 40 percent of gross cross-sectional area) **OR** H60V (void areas between 40 and 60 percent of gross cross-sectional area), **as directed**, Type HBX **OR** HBS **OR** HBA, **as directed**; with glaze complying with ASTM C 126.
  - a. Size: **As directed**.
  - b. Provide Type I (single-faced units) where only one finished face is exposed when units are installed, and Type II (double-faced units) where two opposite finished faces are exposed when units are installed.

#### D. Structural-Clay Facing Tile

1. General:
  - a. Provide solid, multicored, or hollow units, with shape and direction of cores optional, unless otherwise indicated.
  - b. Provide multicored units designed for use in reinforced, grouted masonry.
  - c. Provide special shapes where required for corners, jambs, coved bases, sills, and other special conditions indicated that cannot be produced by sawing standard units.



2. Glazed Structural-Clay Facing Tile: ASTM C 126, Grade S (Select) **OR** SS (Select Sized or Ground Edged), **as directed**.
    - a. Size: **As directed**.
    - b. Provide Type I (single-faced units) where only one finished face is exposed when units are installed, and Type II (double-faced units) where two opposite finished faces are exposed when units are installed.
  3. Unglazed Structural-Clay Facing Tile: ASTM C 212, Type FTX **OR** FTS, **as directed**, Standard **OR** Special-Duty, **as directed**, class.
    - a. Number of Faces: Single faced where only one finished face is exposed when units are installed **OR** Double faced where both finished faces are exposed when units are installed, **as directed**.
- E. Fireplace And Chimney Lining Units
1. Firebox Brick: ASTM C 1261, size required to produce lining thickness indicated.
  2. Clay Flue Lining Units: ASTM C 315.
- F. Stone Trim Units
1. Granite: ASTM C 615.
    - a. Description: Fine **OR** Medium, **as directed**,-grained, white **OR** pink **OR** gray **OR** black, **as directed**, stone. Uniform pattern, without veining.
  2. Limestone: ASTM C 568, Classification I Low **OR** II Medium **OR** III High, **as directed**,-Density.
  3. Marble: ASTM C 503, Classification I Calcite **OR** II Dolomite **OR** III Serpentine **OR** IV Travertine, **as directed**.
    - a. Description: Uniform, fine- to medium-grained, white stone with only slight veining.
  4. Quartz-Based Stone: ASTM C 616, Classification I Sandstone **OR** II Quartzitic Sandstone **OR** III Quartzite, **as directed**.
  5. Finish: Polished **OR** Honed **OR** Smooth **OR** Machine tooled, 4 bats per 1 inch (25 mm) **OR** Machine tooled, 6 bats per 1 inch (25 mm) **OR** Machine tooled, 8 bats per 1 inch (25 mm) **OR** Chat sawed **OR** Split face **OR** Rock face (pitched face), **as directed**.
    - a. Finish for Tops of Sills and Soffits of Lintels: Sand rubbed **OR** Split face, **as directed**.
  6. Provide stone units accurately shaped, with exposed faces dressed true, and with beds and joints at right angles to faces.
    - a. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
    - b. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."
    - c. For marble, comply with recommendations in MIA's "Dimensional Stone--Design Manual IV."
- G. Mortar And Grout Materials
1. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction.
  2. Hydrated Lime: ASTM C 207 **OR** IBC Standard, **as directed**, Type S.
  3. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.
  4. Masonry Cement: ASTM C 91 **OR** IBC Standard, **as directed**.
  5. Mortar Cement: ASTM C 1329 **OR** IBC Standard, **as directed**.
  6. Mortar Pigments: Iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
  7. Colored Cement Product: Packaged blend made from portland cement and lime or masonry cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.
    - a. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
    - b. Pigments shall not exceed 10 percent of portland cement by weight.
    - c. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
  8. Aggregate for Mortar: ASTM C 144.



- a. For joints less than 1/4 inch (6.5 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
  - b. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
  - c. White-Mortar Aggregates: Natural white sand or crushed white stone.
  - d. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
9. Aggregate for Grout: ASTM C 404.
  10. Epoxy Pointing Mortar: ASTM C 395, epoxy-resin-based material formulated for use as pointing mortar for structural-clay tile facing units.
  11. Refractory Mortar Mix: Ground fireclay or non-water-soluble, calcium aluminate, medium-duty refractory mortar that passes ASTM C 199 test; or an equivalent product acceptable to authorities having jurisdiction.
  12. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
  13. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.
  14. Water: Potable.

#### H. Reinforcement

1. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).
2. Masonry Joint Reinforcement, General: ASTM A 951 **OR** IBC Standard, **as directed**.
  - a. Interior Walls: Mill- **OR** Hot-dip, **as directed**, galvanized, carbon steel.
  - b. Exterior Walls: Hot-dip galvanized, carbon **OR** Stainless, **as directed**, steel.
  - c. Wire Size for Side Rods: W1.7 or 0.148-inch (3.8-mm) **OR** W2.8 or 0.188-inch (4.8-mm), **as directed**, diameter.
  - d. Wire Size for Cross Rods: W1.7 or 0.148-inch (3.8-mm) **OR** W2.8 or 0.188-inch (4.8-mm), **as directed** diameter.
  - e. Wire Size for Veneer Ties: W1.7 or 0.148-inch (3.8-mm) **OR** W2.8 or 0.188-inch (4.8-mm), **as directed** diameter.
  - f. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
  - g. Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.
  - h. Multiwythe Masonry:
    - 1) Ladder type with 1 side rod at each face shell of hollow masonry units more than 4 inches (100 mm) in width, plus 1 side rod at each wythe of masonry 4 inches (100 mm) or less in width.
    - 2) Tab type, with 1 side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face.
    - 3) Adjustable (two-piece) type, with one side rod at each face shell of backing wythe and with ties that extend into facing wythe. Ties engage eyes or slots in reinforcement and extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face. Ties have hooks or clips to engage a continuous wire in the facing wythe.
  - i. Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.188-inch- (4.8-mm-) diameter, hot-dip galvanized, carbon-steel continuous wire.

#### I. Ties And Anchors

1. Materials:
  - a. Mill-Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 641/A 641M, Class 1 coating.
  - b. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.



- c. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304 **OR** 316, **as directed**.
  - d. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 (Z180) zinc coating.
  - e. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
  - f. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** 316, **as directed**.
  - g. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
  - h. Stainless Steel bars: ASTM A 276 or ASTM a 666, Type 304.
2. Corrugated Metal Ties: Metal strips not less than 7/8 inch (22 mm) wide with corrugations having a wavelength of 0.3 to 0.5 inch (7.6 to 12.7 mm) and an amplitude of 0.06 to 0.10 inch (1.5 to 2.5 mm) made from steel sheet, galvanized after fabrication **OR** stainless-steel sheet, **as directed**, not less than 0.043 inch (1.1 mm) **OR** 0.053 inch (1.3 mm) **OR** 0.067 inch (1.7 mm) **OR** 0.097 inch (2.5 mm), **as directed**, thick. Ties made from galvanized steel sheet may be used in interior walls, unless otherwise indicated.
  3. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches (50 mm) parallel to face of veneer.
  4. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches (100 mm) wide.
    - a. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches (50 mm) long may be used for masonry constructed from solid units or hollow units laid with cells horizontal.
    - b. Where wythes do not align **OR** are of different materials, **as directed**, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches (32 mm).
    - c. Wire: Fabricate from 3/16-inch- (4.8-mm-) **OR** 1/4-inch- (6.4-mm-), **as directed**, diameter, hot-dip galvanized steel **OR** stainless-steel, **as directed**, wire. Mill-galvanized wire ties may be used in interior walls, unless otherwise indicated.
  5. Adjustable Anchors for Connecting to Structure: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
    - a. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.4-mm-) diameter, hot-dip galvanized steel **OR** stainless-steel, **as directed**, wire. Mill-galvanized wire may be used at interior walls, unless otherwise indicated.
    - b. Tie Section for Steel Frame: Triangular-shaped wire tie, sized to extend within 1 inch (25 mm) of masonry face, made from 0.188-inch- (4.8-mm-) **OR** 0.25-inch- (6.4-mm-), **as directed**, diameter, hot-dip galvanized steel **OR** stainless-steel, **as directed** wire. Mill-galvanized wire may be used at interior walls, unless otherwise indicated.
    - c. Connector Section for Concrete: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.053-inch- (1.3-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.097-inch- (2.5-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.062-inch- (1.6-mm-) thick, stainless-steel sheet **OR** 0.109-inch- (2.8-mm-) thick, stainless-steel sheet, **as directed**. 0.064-inch- (1.6-mm-) **OR** 0.108-inch- (2.7-mm-), **as directed**, thick, galvanized sheet may be used at interior walls, unless otherwise indicated.
    - d. Tie Section for Concrete: Corrugated metal ties with dovetail tabs for inserting into dovetail slots in concrete and sized to extend to within 1 inch (25 mm) of masonry face.
  6. Partition Top anchors: 0.097-inch- (2.5-mm-) thick metal plate with 3/8-inch- (10-mm-) diameter metal rod 6 inches (150 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication **OR** stainless-steel, **as directed**.
  7. Rigid Anchors: Fabricate from steel bars 1-1/2 inches (38 mm) wide by 1/4 inch (6.4 mm) thick by 24 inches (600 mm) long, with ends turned up 2 inches (50 mm) or with cross pins.
    - a. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M **OR** Epoxy coating 0.020 inch (0.51 mm) thick **OR** Rust-inhibitive paint, **as directed**.
  8. Stone Anchors: Fabricate dowels, cramps, and other stone anchors from stainless steel.
  9. Adjustable Masonry-Veneer Anchors



- a. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
  - 1) Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play in excess of 0.05 inch (1.3 mm).
- b. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.
  - 1) Anchor Section:
    - a) Rib-stiffened, sheet metal plate with screw holes top and bottom, and slotted holes for inserting wire tie.
    - b) Sheet metal plate with screw holes top and bottom and with raised rib-stiffened strap, stamped into center to provide a slot between strap and plate for inserting wire tie.
    - c) Gasketed sheet metal plate with screw holes top and bottom; top and bottom ends bent to form pronged legs of length to match thickness of insulation or sheathing; and raised rib-stiffened strap, stamped into center to provide a slot between strap and plate for inserting wire tie. Provide anchor manufacturer's standard, self-adhering, modified bituminous gaskets manufactured to fit behind anchor plate and extend beyond pronged legs.
  - 2) Fabricate sheet metal anchor sections and other sheet metal parts from 0.067-inch- (1.7-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.097-inch- (2.5-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.078-inch- (2.0-mm-) thick, stainless-steel sheet **OR** 0.109-inch- (2.8-mm-) thick, stainless-steel sheet, **as directed**.
  - 3) Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.188-inch- (4.8-mm-) **OR** 0.25-inch- (6.4-mm-), **as directed**, diameter, hot-dip galvanized steel **OR** stainless-steel, **as directed**, wire.
- c. Slip-in, Masonry-Veneer Anchors: Units consisting of a wire tie section and an anchor section designed to interlock with metal studs and be slipped into place as sheathing is installed.
  - 1) Wire-Type Anchor: Bent wire anchor section with an eye to receive the wire tie. Wire tie has a vertical leg that slips into the eye of anchor section and allows vertical adjustment. Both sections are made from 3/16-inch (4.8-mm), hot-dip galvanized wire.
  - 2) Strap-and-Wire Type Anchor: Flat metal strap with notch to interlock with flange of metal stud and two holes for inserting vertical legs of wire tie specially formed to fit anchor section. Strap is made from 0.067-inch- (1.7-mm-) thick, steel sheet, galvanized after fabrication; anchor wire tie is made from 3/16-inch (4.8-mm), hot-dip galvanized wire.
- d. Seismic Masonry-Veneer Anchors: Units consisting of a metal anchor section and a connector section designed to engage a continuous wire embedded in the veneer mortar joint.
  - 1) Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, and slotted holes for inserting connector section.
  - 2) Connector Section: Rib-stiffened, sheet metal bent plate; sheet metal clip; or wire tie and rigid extruded vinyl clip designed to engage continuous wire. Size connector to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face.
  - 3) Fabricate sheet metal anchor sections and other sheet metal parts from 0.067-inch- (1.7-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.097-inch- (2.5-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.078-inch- (2.0-mm-) thick, stainless-steel sheet **OR** 0.109-inch- (2.8-mm-) thick, stainless-steel sheet, **as directed**.



- 4) Fabricate wire connector sections from 0.188-inch- (4.8-mm-) **-OR** 0.25-inch- (6.4-mm-), **as directed**, diameter, hot-dip galvanized, carbon **OR** stainless, **as directed**, steel wire.
  - e. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 (4.8-mm) diameter by length required to penetrate steel stud flange with not less than 3 exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.
  - f. Stainless-Steel Drill Screws for Steel Studs: Proprietary fastener consisting of carbon-steel drill point and 300 Series stainless-steel shank, complying with ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 (4.8-mm) diameter by length required to penetrate steel stud flange with not less than three exposed threads.
- J. Miscellaneous Anchors
1. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.
  2. Dovetail Slots in Concrete: Furnish dovetail slots with filler strips, of slot size indicated, fabricated from 0.034-inch (0.9-mm), galvanized steel sheet.
  3. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.
  4. Postinstalled Anchors: Provide chemical or torque-controlled expansion anchors, with capability to sustain, without failure, a load equal to six times the load imposed when installed in solid or grouted unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
    - a. Corrosion Protection:
      - 1) Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 service condition (mild).
      - 2) Stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group 1 or 4) for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors.
- K. Embedded Flashing Materials
1. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual OR Division 07 Section "Sheet Metal Flashing And Trim" as directed.
    - a. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch (0.4 mm) thick.
    - b. Copper: ASTM B 370, Temper H00 or H01, cold-rolled copper sheet, 10-oz./sq. ft. (3-kg/sq. m) weight or 0.0135 inch (0.34 mm) thick for fully concealed flashing; 16-oz./sq. ft. (5-kg/sq. m) weight or 0.0216 inch (0.55 mm) thick elsewhere.
    - c. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.6 m). Provide splice plates at joints of formed, smooth metal flashing.
    - d. Fabricate through-wall metal flashing embedded in masonry from stainless steel **OR** copper, **as directed**, with ribs at 3-inch (75-mm) intervals along length of flashing to provide an integral mortar bond.
    - e. Metal Drip Edges: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
    - f. Metal Flashing Terminations: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch (19 mm) and down into joint 3/8 inch (10 mm) to form a stop for retaining sealant backer rod.
    - g. Metal Expansion-Joint Strips: Fabricate from stainless steel **OR** copper, **as directed**, to shapes indicated.
  2. Flexible Flashing: For flashing not exposed to the exterior, use one of the following, unless otherwise indicated:



- a. Copper-Laminated Flashing: 5-oz./sq. ft. (1.5-kg/sq. m) **OR** 7-oz./sq. ft. (2-kg/sq. m), **as directed**, copper sheet bonded with asphalt between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.
  - b. Asphalt-Coated Copper Flashing: 5-oz./sq. ft. (1.5-kg/sq. m) **OR** 7-oz./sq. ft. (2-kg/sq. m), **as directed**, copper sheet coated with flexible asphalt. Use only where flashing is fully concealed in masonry.
  - c. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.030 inch (0.8 mm) **OR** 0.040 inch (1.0 mm), **as directed**.
  - d. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy 0.025 inch (0.6 mm) thick, with a 0.015-inch- (0.4-mm-) thick coating of rubberized-asphalt adhesive.
  - e. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D 4637, 0.040 inch (1.0 mm) thick.
3. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from high-density polyethylene incorporating chemical stabilizers that prevent UV degradation. Cell flashing pans have integral weep spouts that are designed to be built into mortar bed joints and weep collected moisture to the exterior of CMU walls and that extend into the cell to prevent clogging with mortar.
  4. Solder and Sealants for Sheet Metal Flashings:
    - a. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
    - b. Solder for Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
    - c. Elastomeric Sealant: ASTM C 920, chemically curing urethane **OR** polysulfide silicone **as directed**, sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
  5. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer.
- L. Miscellaneous Masonry Accessories
1. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; formulated from neoprene, urethane or PVC.
  2. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall.
  3. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
  4. Weep/Vent Products: Use one of the following, unless otherwise indicated:
    - a. Wicking Material: Absorbent rope, made from cotton or UV-resistant synthetic fiber, 1/4 to 3/8 inch (6 to 10 mm) in diameter, in length required to produce 2-inch (50-mm) exposure on exterior and 18 inches (450 mm) in cavity between wythes. Use only for weeps.
    - b. Round Plastic Weep/Vent Tubing: Medium-density polyethylene, 3/8-inch (9-mm) OD by 4 inches (100 mm) long.
    - c. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, 3/8 by 1-1/2 by 3-1/2 inches (9 by 38 by 89 mm) long.
    - d. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe, in color selected from manufacturer's standard.
    - e. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe; in color selected from manufacturer's standard.
    - f. Aluminum Weep Hole/Vent: One-piece, L-shaped units made from sheet aluminum, designed to fit into a head joint and consisting of a vertical channel with louvers stamped in web and with a top flap to keep mortar out of the head joint; painted before installation to



- comply with Division 09 Section(s) "Exterior Painting" OR "Interior Painting", in color approved to match that of mortar.
- g. Vinyl Weep Hole/Vent: One-piece, offset, T-shaped units made from flexible, injection-molded PVC, designed to fit into a head joint and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color approved by Architect to match that of mortar.
5. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
    - a. Provide one of the following configurations:
      - 1) Strips, full-depth of cavity and 10 inches (250 mm) wide, with dovetail shaped notches 7 inches (175 mm) deep.
      - 2) Strips, not less than 1-1/2 inches (38 mm) thick and 10 inches (250 mm) wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
      - 3) Sheets or strips full depth of cavity and installed to full height of cavity.
  6. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch (3.6-mm) steel wire, hot-dip galvanized after fabrication. Provide units with either two loops or four loops as needed for number of bars indicated.
- M. Insulation
1. Loose-Granular Fill Insulation: Perlite complying with ASTM C 549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation).
  2. Molded-Polystyrene Insulation Units: Rigid, cellular thermal insulation formed by the expansion of polystyrene-resin beads or granules in a closed mold to comply with ASTM C 578, Type I. Provide specially shaped units designed for installing in cores of masonry units.
  3. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV **OR X, as directed**, closed-cell product extruded with an integral skin.
  4. Molded-Polystyrene Board Insulation: ASTM C 578, Type I.
  5. Polyisocyanurate Board Insulation: ASTM C 1289, Type I (aluminum-foil-faced), Class 2 (glass-fiber-reinforced).
  6. Adhesive: Type recommended by insulation board manufacturer for application indicated.
- N. Masonry Cleaners
1. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains from new masonry without damaging masonry. Use product approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
- O. Mortar And Grout Mixes
1. General: Do not use admixtures, unless otherwise indicated.
    - a. Do not use calcium chloride in mortar or grout.
    - b. Limit cementitious materials in mortar for exterior and reinforced masonry to portland cement and lime.
    - c. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
  2. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
  3. Mortar for Unit Masonry: Comply with ASTM C 270 **OR** BIA Technical Notes 8A **OR** IBC Standard, **as directed**, Proportion Specification.
  4. Mortar for Unit Masonry: Comply with ASTM C 270 **OR** BIA Technical Notes 8A **OR** IBC Standard, **as directed**, Property Specification.
    - a. For masonry below grade or in contact with earth, use Type M **OR** S, **as directed**.
    - b. For reinforced masonry, use Type S **OR** N, **as directed**.
    - c. For mortar parge coats, use Type S or N.



- d. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
- e. For interior non-load-bearing partitions, Type O may be used instead of Type N.
5. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
  - a. Pigments shall not exceed 10 percent of portland cement by weight.
  - b. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
6. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
7. Grout for Unit Masonry: Comply with ASTM C 476 **OR** IBC Standard, **as directed**.
  - a. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 **OR** Table 21-C in the International Building Code, **as directed**, for dimensions of grout spaces and pour height.
  - b. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C 143/C 143M.
8. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.

### 1.3 EXECUTION

#### A. Installation, General

1. Use full-size units without cutting if possible. If cutting is required, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
2. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
3. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.
4. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
5. Comply with tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:
  - a. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
  - b. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.

#### B. Laying Masonry Walls

1. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
2. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
3. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
4. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.
5. Fill cores in hollow concrete masonry units with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

#### C. Mortar Bedding And Jointing



1. Lay hollow brick and concrete masonry units as follows:
    - a. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
    - b. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
    - c. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
    - d. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
  2. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
  3. Lay structural-clay tile as follows:
    - a. Lay vertical-cell units with full head joints, unless otherwise indicated. Provide bed joints with full mortar coverage on face shells and webs.
    - b. Lay horizontal-cell units with full bed joints, unless otherwise indicated. Keep drainage channels, if any, free of mortar. Form head joints with sufficient mortar so excess will be squeezed out as units are placed in position.
    - c. Maintain joint thicknesses indicated except for minor variations required to maintain bond alignment. If not indicated, lay walls with 1/4- to 3/8-inch- (6- to 10-mm-) thick joints.
    - d. Where epoxy-mortar pointed joints are indicated, rake out setting mortar to a uniform depth of 1/4 inch (6 mm) and point with epoxy mortar.
  4. Set firebox brick in full bed of refractory mortar with full head joints. Form joints by buttering both surfaces of adjoining brick and sliding it into place. Make joints just wide enough to accommodate variations in size of brick, approximately 1/8 inch (3 mm). Tool joints smooth on surfaces exposed to fire or smoke.
  5. Install clay flue liners to comply with ASTM C 1283. Install flue liners ahead of surrounding masonry. Set clay flue liners in full bed of refractory mortar 1/16 to 1/8 inch (1.6 to 3 mm) thick. Strike joints flush on inside of flue to provide smooth surface. Maintain expansion space between flue liner and surrounding masonry except where surrounding masonry is required to provide lateral support for flue liners.
  6. Set stone **OR** cast-stone, **as directed**, trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
  7. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.
  8. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.
- D. Composite Masonry
1. Bond wythes of composite masonry together using one of the following methods:
    - a. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 4.5 sq. ft. (0.42 sq. m) **OR** 2.67 sq. ft. (0.25 sq. m), **as directed**, of wall area spaced not to exceed 36 inches (914 mm) **OR** 24 inches (610 mm), **as directed**, o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (915 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.
      - 1) Where bed joints of wythes do not align, use adjustable (two-piece) type ties.
    - b. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
      - 1) Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes **OR** tab-type reinforcement, **as directed**.
      - 2) Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties.
  2. Collar Joints: Solidly fill collar joints by parging face of first wythe that is laid and shoving units of other wythe into place.
  3. Collar Joints in Clay Tile Masonry: After each course is laid, fill the vertical, longitudinal joint between wythes solidly with mortar at exterior walls, except cavity walls, and interior walls and partitions.



4. Corners: Provide interlocking masonry unit bond in each wythe and course at corners, unless otherwise indicated.
5. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together as follows:
  - a. Provide individual metal ties not more than 8 inches (203 mm) **OR** 16 inches (406 mm), **as directed**, o.c.
  - b. Provide continuity with masonry joint reinforcement by using prefabricated T-shaped units.
  - c. Provide rigid metal anchors not more than 24 inches (610 mm) **OR** 48 inches (1220 mm), **as directed**, o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

#### E. Cavity Walls

1. Bond wythes of cavity walls together using one of the following methods:
  - a. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 4.5 sq. ft. (0.42 sq. m) **OR** 2.67 sq. ft. (0.25 sq. m), **as directed**, of wall area spaced not to exceed 36 inches (914 mm) **OR** 24 inches (610 mm), **as directed**, o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (915 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.
  - b. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
    - 1) Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes **OR** tab-type reinforcement, **as directed**.
    - 2) Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties.
    - 3) Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
  - c. Masonry Veneer Anchors: Comply with requirements for anchoring masonry veneers.
2. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
3. Parge cavity face of backup wythe in a single coat approximately 3/8 inch (10 mm) thick. Trowel face of parge coat smooth.  
**OR**  
Coat cavity face of backup wythe to comply with Division 07 Section "Bituminous Dampproofing".

- #### F. Installing Cavity-Wall Insulation:
- Place small dabs of adhesive, spaced approximately 12 inches (300 mm) o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit insulation between wall ties and other confining obstructions, with edges butted tightly. Press units firmly against inside wythe of masonry.

#### G. Masonry-Cell Insulation

1. Pour granular insulation into cavities to fill void spaces. Maintain inspection ports to show presence of insulation at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of insulation to 1 story in height, but not more than 20 feet (6 m).
2. Install molded-polystyrene insulation units into masonry unit cells before laying units.

#### H. Masonry Joint Reinforcement

1. General: Install in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
2. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
3. Provide continuity at wall intersections by using prefabricated T-shaped units.
4. Provide continuity at corners by using prefabricated L-shaped units.



- I. Anchoring Masonry To Structural Members
1. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:
    - a. Provide an open space not less than 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**, in width between masonry and structural member, unless otherwise indicated.
    - b. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
    - c. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.
- J. Anchoring Masonry Veneers
1. Anchor masonry veneers to wall framing **OR** concrete and masonry backup, **as directed**, with seismic masonry-veneer anchors to comply with the following requirements:
    - a. Fasten screw-attached and seismic anchors through sheathing to wall framing and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners.
    - b. Insert slip-in anchors in metal studs as sheathing is installed. Provide one anchor at each stud in each horizontal joint between sheathing boards.
    - c. Embed tie sections **OR** connector sections and continuous wire, **as directed**, in masonry joints. Provide not less than 2 inches (50 mm) of air space between back of masonry veneer and face of sheathing.
    - d. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
    - e. Space anchors as indicated, but not more than 16 inches (406 mm) o.c. vertically and 32 inches (813 mm) **OR** 24 inches (610 mm), **as directed**, o.c. horizontally with not less than 1 anchor for each 3.5 sq. ft. (0.33 sq. m) **OR** 2.67 sq. ft. (0.25 sq. m), **as directed**, of wall area. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 36 inches (914 mm), around perimeter.
- K. Control And Expansion Joints
1. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
  2. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants", but not less than 3/8 inch (10 mm).
    - a. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.
- L. Lintels
1. Provide concrete or masonry lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.
  2. Provide minimum bearing of 8 inches (200 mm) at each jamb, unless otherwise indicated.
- M. Flashing, Weep Holes, Cavity Drainage, And Vents
1. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
  2. Install flashing as follows, unless otherwise indicated:
    - a. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing as recommended by flashing manufacturer.
    - b. At lintels and shelf angles, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.



- c. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal drip edge.
- d. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
3. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
4. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
5. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
  - a. Use specified weep/vent products or open head joints to form weep holes.
  - b. Space weep holes 24 inches (600 mm) o.c., unless otherwise indicated.
  - c. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
6. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.
7. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products or open head joints to form vents.
  - a. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

#### N. Reinforced Unit Masonry Installation

1. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
  - a. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
  - b. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
2. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602 **OR** Section 2104.5 in the International Building Code, **as directed**.
  - a. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
  - b. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 **OR** Section 2104.6 in the International Building Code, **as directed**, for cleanouts and for grout placement, including minimum grout space and maximum pour height.
  - c. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

#### O. Field Quality Control

1. Inspectors: Engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
  - a. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.
2. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:
3. Testing Frequency: One set of tests for each 5000 sq. ft. (465 sq. m) of wall area or portion thereof.
4. Clay Masonry Unit Test: For each type of unit provided, per ASTM C 67.



5. Concrete Masonry Unit Test: For each type of unit provided, per ASTM C 140.
  6. Mortar Test (Property Specification): For each mix provided, per ASTM C 780 **OR** IBC Standard, **as directed**. Test mortar for mortar air content and compressive strength.
  7. Grout Test (Compressive Strength): For each mix provided, per ASTM C 1019 **OR** IBC Standard, **as directed**.
- P. Parging
1. Parge exterior faces of below-grade masonry walls, where indicated, in 2 uniform coats to a total thickness of 3/4 inch (19 mm) with a steel-trowel finish. Form a wash at top of parging and a cove at bottom. Damp-cure parging for at least 24 hours and protect parging until cured.
- Q. Cleaning
1. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
  2. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
    - a. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
    - b. Protect adjacent surfaces from contact with cleaner.
    - c. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
    - d. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
    - e. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
    - f. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.
- R. Masonry Waste Disposal
1. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
    - a. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.
    - b. Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off the Owner's property.

END OF SECTION 01 54 23 00a



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
01 54 23 00	01 22 16 00	No Specification Required
01 54 26 00	01 22 16 00	No Specification Required
01 54 29 00	01 22 16 00	No Specification Required
01 55 23 00	01 22 16 00	No Specification Required
01 55 26 00	01 22 16 00	No Specification Required
01 56 16 00	01 22 16 00	No Specification Required



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## SECTION 01 56 26 00 - SEDIMENT REMOVAL

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing of labor and equipment for sediment removal.

### 1.2 PRODUCTS - (Not Used)

### 1.3 EXECUTION

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

END OF SECTION 01 56 26 00



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## SECTION 01 56 26 00a - EROSION CONTROL

### 1.1 GENERAL

#### A. Description Of Work

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

### 1.2 PRODUCTS

#### A. Materials

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

### 1.3 EXECUTION:

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

END OF SECTION 01 56 26 00a



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
01 56 26 00	01 22 16 00	No Specification Required
01 56 29 00	01 22 16 00	No Specification Required
01 56 33 00	01 22 16 00	No Specification Required
01 56 39 00	01 22 16 00	No Specification Required
01 57 13 00	01 56 26 00	Sediment Removal
01 58 13 00	01 22 16 00	No Specification Required
01 66 19 00	01 22 16 00	No Specification Required
01 71 13 00	01 22 16 00	No Specification Required



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## SECTION 01 71 23 16 - CUTTING AND PATCHING

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

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

#### C. Definitions

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

#### D. Submittals

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

#### E. Quality Assurance

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



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

#### F. Warranty

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

## 1.2 PRODUCTS

### A. Materials

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



### 1.3 EXECUTION

#### A. Preparation

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

#### B. Performance

1. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
  - a. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
2. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
  - a. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
  - b. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  - c. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  - d. Excavating and Backfilling: Comply with requirements in applicable Division 31 where required by cutting and patching operations.
  - e. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
  - f. Proceed with patching after construction operations requiring cutting are complete.
3. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
  - a. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
  - b. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
    - 1) Clean piping, conduit, and similar features before applying paint or other finishing materials.
    - 2) Restore damaged pipe covering to its original condition.
  - c. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
    - 1) Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.



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- d. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
  - e. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.
4. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION 01 71 23 16



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
01 74 16 00	01 22 16 00	No Specification Required

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**SECTION 01 74 19 00 - CONSTRUCTION WASTE MANAGEMENT**

## 1.1 GENERAL

## A. Summary

1. This Section includes administrative and procedural requirements for the following:
  - a. Salvaging nonhazardous demolition and construction waste.  
**Note: All salvageable materials remain the property of the Owner and shall be turned over as directed when specified in the Job Order.**
  - b. Recycling nonhazardous demolition and construction waste.
  - c. Disposing of nonhazardous demolition and construction waste.

## B. Definitions

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

C. Performance Goals **OR** Requirements, **as directed**

1. General: Develop waste management plan that results in end-of-Project rates for salvage/recycling of 50 **OR** 75, **as directed**, percent by weight of total waste generated by the Work.
2. Salvage/Recycle Goals **OR** Requirements, **as directed**: Owner's goal is to salvage and recycle as much nonhazardous demolition and construction waste as possible including the following materials:  
**OR**  
Salvage/Recycle Goals **OR** Requirements, **as directed**: Owner's goal is to salvage and recycle as much nonhazardous demolition and construction waste as possible. Owner has established minimum goals for the following materials:
  - a. Demolition Waste:
    - 1) Asphaltic concrete paving.
    - 2) Concrete.
    - 3) Concrete reinforcing steel.
    - 4) Brick.
    - 5) Concrete masonry units.
    - 6) Wood studs.
    - 7) Wood joists.
    - 8) Plywood and oriented strand board.
    - 9) Wood paneling.
    - 10) Wood trim.
    - 11) Structural and miscellaneous steel.
    - 12) Rough hardware.
    - 13) Roofing.
    - 14) Insulation.
    - 15) Doors and frames.



- 16) Door hardware.
- 17) Windows.
- 18) Glazing.
- 19) Metal studs.
- 20) Gypsum board.
- 21) Acoustical tile and panels.
- 22) Carpet.
- 23) Carpet pad.
- 24) Demountable partitions.
- 25) Equipment.
- 26) Cabinets.
- 27) Plumbing fixtures.
- 28) Piping.
- 29) Supports and hangers.
- 30) Valves.
- 31) Sprinklers.
- 32) Mechanical equipment.
- 33) Refrigerants.
- 34) Electrical conduit.
- 35) Copper wiring.
- 36) Lighting fixtures.
- 37) Lamps.
- 38) Ballasts.
- 39) Electrical devices.
- 40) Switchgear and panelboards.
- 41) Transformers.
- b. Construction Waste:
  - 1) Site-clearing waste.
  - 2) Masonry and CMU.
  - 3) Lumber.
  - 4) Wood sheet materials.
  - 5) Wood trim.
  - 6) Metals.
  - 7) Roofing.
  - 8) Insulation.
  - 9) Carpet and pad.
  - 10) Gypsum board.
  - 11) Piping.
  - 12) Electrical conduit.
  - 13) Packaging: Regardless of salvage/recycle goal indicated above, salvage or recycle 100 percent of the following uncontaminated packaging materials:
    - a) Paper.
    - b) Cardboard.
    - c) Boxes.
    - d) Plastic sheet and film.
    - e) Polystyrene packaging.
    - f) Wood crates.
    - g) Plastic pails.

D. Submittals

1. Waste Management Plan: Submit 3 copies of plan within 7 **OR** 30, **as directed**, days of date established for commencement of the Work **OR** the Notice to Proceed **OR** the Notice of Award, **as directed**.



2. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit three copies of report. Include separate reports for demolition and construction waste, **as directed**. Include the following information:
    - a. Material category.
    - b. Generation point of waste.
    - c. Total quantity of waste in tons (tonnes).
    - d. Quantity of waste salvaged, both estimated and actual in tons (tonnes).
    - e. Quantity of waste recycled, both estimated and actual in tons (tonnes).
    - f. Total quantity of waste recovered (salvaged plus recycled) in tons (tonnes).
    - g. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
  3. Waste Reduction Calculations: Before request for Final Completion, submit three copies of calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
  4. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
  5. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
  6. LEED Submittal: LEED letter template for Credit MR 2.1 and 2.2, **as directed**, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met.
  7. Qualification Data: For Waste Management Coordinator and refrigerant recovery technician.
  8. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- E. Quality Assurance
1. Waste Management Coordinator Qualifications: LEED Accredited Professional by U.S. Green Building Council. Waste management coordinator may also serve as LEED coordinator.
  2. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
  3. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
  4. Waste Management Conference: Conduct conference at Project site. Review methods and procedures related to waste management including, but not limited to, the following:
    - a. Review and discuss waste management plan including responsibilities of Waste Management Coordinator.
    - b. Review requirements for documenting quantities of each type of waste and its disposition.
    - c. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
    - d. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
    - e. Review waste management requirements for each trade.
- F. Waste Management Plan
1. General: Develop plan consisting of waste identification, waste reduction work plan, and cost/revenue analysis. Include separate sections in plan for demolition and construction waste if Project requires selective demolition or building demolition. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
  2. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing, and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.
  3. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.



- a. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
  - b. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
  - c. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
  - d. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.
4. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Include the following:
- a. Total quantity of waste.
  - b. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.
  - c. Total cost of disposal (with no waste management).
  - d. Revenue from salvaged materials.
  - e. Revenue from recycled materials.
  - f. Savings in hauling and tipping fees by donating materials.
  - g. Savings in hauling and tipping fees that are avoided.
  - h. Handling and transportation costs. Include cost of collection containers for each type of waste.
  - i. Net additional cost or net savings from waste management plan.

## 1.2 PRODUCTS (Not Used)

## 1.3 EXECUTION

### A. Plan Implementation

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

### B. Salvaging Demolition Waste



1. Salvaged Items for Reuse in the Work:
    - a. Clean salvaged items.
    - b. Pack or crate items after cleaning. Identify contents of containers.
    - c. Store items in a secure area until installation.
    - d. Protect items from damage during transport and storage.
    - e. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
  2. Salvaged Items for Sale and Donation: Not permitted.
  3. Salvaged Items for Owner's Use:
    - a. Clean salvaged items.
    - b. Pack or crate items after cleaning. Identify contents of containers.
    - c. Store items in a secure area until delivery to Owner.
    - d. Transport items to Owner's storage area on-site **OR** off-site **OR** designated by Owner, **as directed**.
    - e. Protect items from damage during transport and storage.
  4. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.
- C. Recycling Demolition And Construction Waste, General
1. General: Recycle paper and beverage containers used by on-site workers.
  2. Recycling Receivers and Processors: Refer to the Owner for available recycling receivers and processors.
  3. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Owner **OR** accrue to Contractor **OR** be shared equally by Owner and Contractor, **as directed**.
  4. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical.
    - a. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
      - 1) Inspect containers and bins for contamination and remove contaminated materials if found.
    - b. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
    - c. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
    - d. Store components off the ground and protect from the weather.
    - e. Remove recyclable waste off Owner's property and transport to recycling receiver or processor.
- D. Recycling Demolition Waste
1. Asphaltic Concrete Paving: Grind asphalt to maximum 1-1/2-inch (38-mm) **OR** 4-inch (100-mm), **as directed**, size.
    - a. Crush asphaltic concrete paving and screen to comply with requirements in Division 31 Section "Earth Moving" for use as general fill.
  2. Asphaltic Concrete Paving: Break up and transport paving to asphalt-recycling facility.
  3. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
    - a. Pulverize concrete to maximum 1-1/2-inch (38-mm) **OR** 4-inch (100-mm), **as directed**, size.
    - b. Crush concrete and screen to comply with requirements in Division 31 Section "Earth Moving" for use as satisfactory soil for fill or subbase.
  4. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
    - a. Pulverize masonry to maximum 3/4-inch (19-mm) **OR** 1-inch (25-mm) **OR** 1-1/2-inch (38-mm) **OR** 4-inch (100-mm), **as directed**, size.



- 1) Crush masonry and screen to comply with requirements in Division 31 Section "Earth Moving" for use as general fill **OR** satisfactory soil for fill or subbase, **as directed**.
  - 2) Crush masonry and screen to comply with requirements in Division 32 Section "Plants" for use as mineral mulch.
    - b. Clean and stack undamaged, whole masonry units on wood pallets.
  5. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
  6. Metals: Separate metals by type.
    - a. Structural Steel: Stack members according to size, type of member, and length.
    - b. Remove and dispose of bolts, nuts, washers, and other rough hardware.
  7. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.
  8. Gypsum Board: Stack large clean pieces on wood pallets and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.
  9. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
    - a. Separate suspension system, trim, and other metals from panels and tile and sort with other metals.
  10. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
    - a. Store clean, dry carpet and pad in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.
  11. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
  12. Plumbing Fixtures: Separate by type and size.
  13. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.
  14. Lighting Fixtures: Separate lamps by type and protect from breakage.
  15. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.
  16. Conduit: Reduce conduit to straight lengths and store by type and size.
- E. Recycling Construction Waste
1. Packaging:
    - a. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
    - b. Polystyrene Packaging: Separate and bag materials.
    - c. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
    - d. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
  2. Site-Clearing Wastes: Chip brush, branches, and trees on-site **OR** at landfill facility, **as directed**.
    - a. Comply with requirements in Division 32 Section "Plants" for use of chipped organic waste as organic mulch.
  3. Wood Materials:
    - a. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
    - b. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
      - 1) Comply with requirements in Division 32 Section "Plants" for use of clean sawdust as organic mulch.
  4. Gypsum Board: Stack large clean pieces on wood pallets and store in a dry location.
    - a. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.
      - 1) Comply with requirements in Division 32 Section "Plants" for use of clean ground gypsum board as inorganic soil amendment.



F. Disposal Of Waste

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

END OF SECTION 01 74 19 00



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**SECTION 02 81 00 00 - EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL**

## 1.1 GENERAL

## A. Description Of Work

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

## B. Submittals

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

## C. Surveys

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

## D. Regulatory Requirements

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

## E. Chemical Testing

1. Required sampling and chemical analysis shall be conducted in accordance with local requirements and the Owner's requirements.



## F. Scheduling

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

## 1.2 PRODUCTS

## A. Backfill

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

<u>Physical Parameter</u>	<u>Test Method</u>
Grain Size	ASTM D 422
Compaction	ASTM D 698

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

## B. Spill Response Materials

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

## 1.3 EXECUTION

## A. Existing Structures And Utilities

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

## B. Clearing

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

## C. Contaminated Material Removal

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



3. Dewatering: Surface water shall be diverted to prevent entry into the excavation. Dewatering shall be limited to that necessary to assure adequate access, a safe excavation, prevent the spread of contamination, and to ensure that compaction requirements can be met. No dewatering shall be performed without prior approval of the Owner.
- D. Confirmation Sampling And Analysis
1. the Owner shall be present to inspect the removal of contaminated material from each site. After all material suspected of being contaminated has been removed, the excavation shall be examined for evidence of contamination. If the excavation appears to be free of contamination, field analysis shall be used to determine the presence of contamination using a real time vapor monitoring instrument **OR** immunoassay field kits, **as directed**. Excavation of additional material shall be as directed by the Owner. After all suspected contaminated material is removed, confirmation samples shall be collected and analyzed.
  2. Samples shall be collected at a frequency as directed by the Owner. A minimum of one sample shall be collected from the bottom and each side wall of the excavation. Based on test results, the Contractor shall propose any additional excavation which may be required to remove material which is contaminated above action levels. Additional excavation shall be subject to approval by the Owner. Locations of samples shall be marked in the field and documented on the as-built drawings.
- E. Contaminated Material Storage
1. Material shall be placed in temporary storage immediately after excavation **OR** after treatment while awaiting test results, **as directed**. The following paragraphs describe acceptable methods of material storage. Storage units shall be in good condition and constructed of materials that are compatible with the material or liquid to be stored. If multiple storage units are required, each unit shall be clearly labeled with an identification number and a written log shall be kept to track the source of contaminated material in each temporary storage unit.
  2. Stockpiles
    - a. Stockpiles shall be constructed to isolate stored contaminated material from the environment. The maximum stockpile size shall be as directed by the Owner. Stockpiles shall be constructed to include:
      - 1) A chemically resistant geomembrane liner free of holes and other damage. Non-reinforced geomembrane liners shall have a minimum thickness of 20 mils (0.5 mm). Scrim reinforced geomembrane liners shall have a minimum weight of 40 lbs. per 1000 square feet (20 kg/100 square meters). The ground surface on which the geomembrane is to be placed shall be free of rocks greater than 0.5 inches (12 mm) in diameter and any other object which could damage the membrane.
      - 2) Geomembrane cover free of holes or other damage to prevent precipitation from entering the stockpile. Non-reinforced geomembrane covers shall have a minimum thickness of 10 mils (0.25 mm). Scrim reinforced geomembrane covers shall have a minimum weight of 26 lbs. per 1000 square feet (13 kg/100 square meters). The cover material shall be extended over the berms and anchored or ballasted to prevent it from being removed or damaged by wind.
      - 3) Berms surrounding the stockpile, a minimum of 12 inches (300 mm) in height. Vehicle access points shall also be bermed.
      - 4) The liner system shall be sloped to allow collection of leachate. Storage and removal of liquid which collects in the stockpile, in accordance with paragraph Liquid Storage.
  3. Roll-Off Units: Roll-off units used to temporarily store contaminated material shall be water tight. A cover shall be placed over the units to prevent precipitation from contacting the stored material. The units shall be located as shown on the drawings. Liquid which collects inside the units shall be removed and stored in accordance with paragraph Liquid Storage.
  4. Liquid Storage: Liquid collected from excavations and stockpiles shall be temporarily stored in 55 gallon barrels (220 L barrels) **OR** 500 gallon tanks (2000 L tanks), **as directed**. Liquid storage containers shall be water-tight and shall be located as shown on the drawings.



#### F. Sampling

##### 1. Sampling of Stored Material

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

**OR**

Stored material with contaminant levels that exceed the action levels shall be treated onsite.

##### 2. Sampling Liquid

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

**OR**

Liquid with contaminant levels that exceed action levels shall be treated onsite.

##### 3. Sampling Beneath Storage Units

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

#### G. Spills

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

#### H. Backfilling

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



2. Compaction: Approved backfill shall be placed in lifts with a maximum loose thickness of 8 inches (200 mm). Soil shall be compacted to 90 percent of ASTM D 698 **OR** ASTM D 1557, **as directed**, maximum dry density. Density tests shall be performed at a frequency of once per 10,000 square feet (930 square meters) per lift. A minimum of one density test shall be performed on each lift of backfill placed. Field in-place dry density shall be determined in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 2922. If ASTM D 2922 is used, a minimum of one in ten tests shall be checked using ASTM D 1556 or ASTM D 2167. Test results from ASTM D 1556 or ASTM D 2167 shall govern if there is a discrepancy with the ASTM D 2922 test results.
  - I. Disposal Requirements
    1. Offsite disposal of contaminated material shall be in accordance with Division 2 Section "Disposal of Hazardous Materials."
  - J. Closure Report
    1. Three copies of a Closure Report shall be prepared and submitted within 14 calendar days of completing work at the site. The report shall be labeled with the contract number, project name, location, date, and name of general contractor. The Closure Report shall include the following information as a minimum:
      - a. A cover letter signed by a responsible company official **OR** Professional Engineer registered in the state of the work who is a responsible company official, **as directed**, certifying that all services involved have been performed in accordance with the terms and conditions of the contract documents and regulatory requirements.
      - b. A narrative report including, but not limited to, the following:
        - 1) site conditions, ground water elevation, and cleanup criteria;
        - 2) excavation logs;
        - 3) field screening readings;
        - 4) quantity of materials removed from each area of contamination;
        - 5) quantity of water/product removed during dewatering;
        - 6) sampling locations and sampling methods;
        - 7) sample collection data such as time of collection and method of preservation;
        - 8) sample chain-of-custody forms; and
        - 9) source of backfill.
      - c. Copies of all chemical and physical test results.
      - d. Copies of all manifests and land disposal restriction notifications.
      - e. Copies of all certifications of final disposal signed by the responsible disposal facility official.
      - f. Waste profile sheets.
      - g. Scale drawings showing limits of each excavation, limits of contamination, known underground utilities within 50 feet (15 m) of excavation, sample locations, and sample identification numbers. On-site stockpile, storage, treatment, loading, and disposal areas shall also be shown on the drawings.
      - h. Progress Photographs. Color photographs shall be used to document progress of the work. A minimum of four views of the site showing the location of the area of contamination, entrance/exit road, and any other notable site conditions shall be taken before work begins. After work has been started, activities at each work location shall be photographically recorded daily **OR** weekly, **as directed**. Photographs shall be a minimum of 3 x 5 inches (76.2 x 127.0 mm) and shall include:
        - 1) Soil removal and sampling.
        - 2) Dewatering operations.
        - 3) Unanticipated events such as spills and the discovery of additional contaminated material.
        - 4) Contaminated material/water storage, handling, treatment, and transport.
        - 5) Site or task-specific employee respiratory and personal protection.
        - 6) Fill placement and grading.



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- 7) Post-construction photographs. After completion of work at each site, the Contractor shall take a minimum of four views of each excavation site. A digital version of all photos shown in the report shall be included with the Closure Report. Photographs shall be a minimum of 3 inches by 5 inches (76mm by 127 mm) and shall be mounted back-to-back in double face plastic sleeves punched to fit standard three ring binders. Each print shall have an information box attached. The box shall be typewritten and arranged as follows:
- Project Name: Direction of View:
  - Location: Date/Time:
  - Photograph No.: Description of View:

END OF SECTION 02 81 00 00



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**SECTION 02 81 00 00a - DISPOSAL OF HAZARDOUS MATERIALS****1.1 GENERAL****A. Description Of Work**

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

**B. Definition**

1. Hazardous materials shall be defined as asbestos containing materials, lead-based paint, PCBs, bird waste, and other materials categorized as hazardous by the EPA.

**C. Submittals**

1. Before start of work: At the pre-construction meeting, the Contractor shall submit the following to the Owner's Representative for review. Do not start work until these submittal are returned with Owner's Representative stamp indicating that the submittal is returned for unrestricted use.
  - a. Copy of State or local license for hazardous waste hauler.
  - b. Certificate of at least one on-site supervisor which has satisfactorily completed the OSHA 40 hour Health and Safety course for handling hazardous materials.
  - c. Certificates of workers which have successfully completed the OSHA 40-Hour Health and Safety Course for Hazardous Materials.
  - d. List of the employees scheduled to perform this work.
  - e. Schedule of start and finish times and dates for this work.
  - f. Name and address of landfill where these waste materials are to be deposited. Include contact person and telephone number.
  - g. Material Safety Data Sheet (MSDS) for all materials to be removed.
  - h. If contractor introduces any chemical into the work environment, a MSDS for that chemical must be presented to the Owner's Representative prior to use.
  - i. Transporter must have notified the EPA and/or other appropriate local government agency in advance of its intentions to transport hazardous materials and, if applicable, receive an identification number.
  - j. Contingency Plan for handling emergencies with spills or leaks.
  - k. Certificates of workers which have successfully completed the OSHA 24-Hour Health and Safety Course for Hazardous Materials.

**1.2 PRODUCTS****A. Materials**

1. Drums: Recovery or salvage drums acceptable for disposal of hazardous waste. Prior approval of drums is required. Drums or containers must meet the required OSHA, EPA (40 CFR Parts 264-264 and 300), and DOT Regulations (49 CFR Parts 171-178). Use of damaged containers shall not be allowed.
2. Labels: As required by the EPA and OSHA for handling, transportation, and disposal of hazardous waste.
3. Absorbent Material: Clay, soil or any commercially available absorbent used for the purpose of absorbing hazardous or potentially hazardous materials.

**1.3 EXECUTION**



- 
- A. All waste shall be transported and disposed of in accordance with all federal, state and local guidelines and regulations. The contractor is to obtain all permits, licenses, etc., which are necessary for the transporting and disposal of hazardous waste.
  - B. Waste haulers shall maintain waste manifest and shipment record forms.

END OF SECTION 02 81 00 00a

**SECTION 02 82 16 00 - ENCAPSULATION (LOCK-DOWN) OF ASBESTOS-CONTAINING MATERIALS**

## 1.1 GENERAL

## A. Description Of Work

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

## B. Submittals

1. Product Data: Manufacturers technical information including label analysis and application instructions for each material proposed for use.
2. Installation Instructions: Manufacturer's installation instructions with specific project requirements noted.
3. Performance Warrantee: Manufacturers performance guarantee.
4. Material Safety Data Sheet: Material Safety Data Sheet in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200) for each surfactant and encapsulating material proposed for use on the work. Include a separate attachment for each sheet indicating the specific worker protective equipment proposed for use with the material indicated.

## C. Delivery And Storage: Deliver materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:

1. Name or title of material
2. Manufacturer's stock number and date of manufacture
3. Manufacturer's name
4. Thinning instructions
5. Application instructions
6. Deliver materials together with a copy of the OSHA Material
7. Safety Data Sheet for the material.

## D. Job Conditions: Apply encapsulating materials only when environmental conditions in the work area are as required by the manufacturer's instructions.

## E. Quality Assurance

1. Testing: Test material to be encapsulated using methods set forth in ASTM E1494 "Standard Practice for Encapsulants for Spray-or-Trowel-Applied Friable Asbestos- Containing Building Materials."

## F. Warranty

1. Performance Warranty: Contractor shall submit written Performance Warranty, executed by the contractor, agreeing to repair/replace spray-on work which has cracked, fallen from substrate, or otherwise deteriorated to a condition where it would not perform effectively for its intended purposes due substantially to defective materials or workmanship and not due to abuse by occupants, improper maintenance, unforeseeable ambient exposures or other causes beyond anticipated conditions and contractors control. Warranty period shall be for at least one year after date of Final Completion.

## 1.2 PRODUCTS

## A. Materials



1. Encapsulant system shall be an acrylic, elastomeric type, spray, brush or roller-applied, tinted penetrating or tinted bridging type, specifically designed for application to asbestos-containing material. System shall be equal to Global Encasement System as manufactured by GLOBAL Encasement Inc., 132-32nd Street, Union City, NJ 07087 U.S.A., Tel. (800) 266-3982/(201) 902-9770.
    - a. All encasement topcoat materials shall be warranted to be heavy-bodied, from the same manufacturer, and shall be long lasting, highly-pure (low VOC) materials that remain flexible, chalk resistant and resist cracking, peeling, algae and fungus that can cause future indoor air quality concerns.
    - b. To allow for building movement without cracking or disturbing fibrous materials, coating systems shall have passed testing to ASTM standards for adhesion, permeability, aged flexibility and with aged elasticity for the encasement system of over 250%.
    - c. Coatings shall be Class A Fire Rated, water-based, non-toxic, safe and easy to use, contain no hazardous ingredients by OSHA definition, comply with all known building codes and be non-flammable.
    - d. Coating materials shall have low VOC (Volatile Organic Compound) content.
    - e. Coating materials shall not release health threatening toxic smoke and fumes in a fire and shall comply with all known building codes.
    - f. Coating materials shall have passed the following testing standards:
      - 1) ASTM E 119 fire tests demonstrating that applying a multi-layer system over fireproofing does not adversely affect the fireproof rating of the fireproofing (3 hour test).
      - 2) UPITT Combustion Toxicity Test proving nothing toxic is released in a fire.
      - 3) ASTM E 84 and E162 fire tests for "Class A" - Surface Flammability and Burning Characteristics (Flame Spread = 0, Smoke Developed = 5).
      - 4) "Pull-off Adhesion" test per ASTM E736 equals or exceeds 9,950 lbs./sq. ft. (89.1 lbs./sq. in.).
      - 5) ASTM D 1653 and E96 "Water Vapor Permeability" (showing the rate that water vapor can pass through the system).
      - 6) Impact Resistance, "Tensile Strength" shall exceed 150 psi; "Elongation" shall exceed 250%.
      - 7) System shall be mildew resistant, impact resistant, scrub resistant, non-yellowing, non-chalking, highly blister resistant, rust resistant, highly chemical resistant and shall remain flexible after 1000 hour ASTM Accelerated Weather testing.
      - 8) Water-Based materials (low VOC) Volatile Organic Content of Primer-Sealer-Neutralizer = 0.1 g/L (0.001 lb./gal.) and Encasement Top Coat = 0.1 g/L (0.001 lb./gal.) as tested by EPA Method 24.
      - 9) Materials comply with applicable standards for installation on interior and/or exterior surfaces of a building.
      - 10) Encasement Systems shall provide additional water-proofing protection.
- B. Related Materials:
1. Elastomeric architectural sealants, caulking compounds, primers, and similar materials shall be approved by the manufacturer of the encasement coatings. All materials used shall be applied in accordance with its manufacturer's recommendations.
- C. Applicable Standards
1. Product shall be rated as acceptable for use intended when field tested in accordance with ASTM E 1494.

### 1.3 EXECUTION

#### A. General



1. Prior to applying any encapsulating material in Work Areas, Contractor shall obtain final visual inspection approval by the Project Administrator.
  2. Prior to applying any encapsulating material, Contractor shall ensure that application of the sealer will not cause the base material to fail and allow the sealed material to fall of its own weight or separate from the substrate. Should Contractor doubt the ability of the installation to support the sealant, request direction from the Owner's Representative before proceeding with the encapsulating work.
  3. Do Not Commence Application of encapsulating materials until all removal work within the work area has been completed.
- B. Worker Protection
1. Before beginning work with any material for which a Material Safety Data Sheet has been submitted provide workers with the required protective equipment. Require that appropriate protective equipment be used at all times.
- C. Application
1. Comply with all manufacturer's instructions for particular conditions of installation. Consult with manufacturer's technical representative for conditions not covered.
  2. Encapsulate all surfaces in full compliance with manufacturer's procedures.
  3. At completion of Encapsulation and before removal of Work Area enclosures and Pressure Differential System, decontaminate space in accordance with requirements of manufacturer's instructions.
  4. Remove all debris from the project site and restore area to proper conditions by cleaning all surfaces in accordance with manufacturer's written recommendations.
  5. At completion of work submit manufacturer's record of inspection of completed work and Manufacturers Performance Guarantee executed by both manufacturer and Contractor.

END OF SECTION 02 82 16 00



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**SECTION 02 82 33 00 - REMOVAL OF FRIABLE ASBESTOS-CONTAINING MATERIALS****1.1 GENERAL****A. Description Of Work**

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

**B. Description**

1. Furnish all labor, materials, facilities, equipment, services, employee training and testing, permits and agreements necessary to perform the work required for asbestos removal, encapsulation, repair, clean-up, decontamination, re-insulation and all other work in accordance with these specifications, in accordance with the latest regulations from the U.S. Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the recommendations of National Institute of Occupational Safety and Health (NIOSH), and any other applicable federal, state and local government regulations. Whenever there is a conflict or overlap of the above references, the most stringent provision is applicable.
2. The work specified herein shall be performed by competent persons trained, knowledgeable and qualified in the state-of-the-art techniques of asbestos abatement, handling and subsequent cleaning of contaminated areas.

**C. Scope**

1. The quantities of materials and limits of abatement work area(s) shall be verified by the asbestos contractor.

**D. Asbestos Hazard**

1. Asbestos-containing material when damaged or disturbed is subject to fiber releases. Wet methods are a primary means of controlling fiber release.
2. Strict compliance with each of the provisions outlined in these specifications for the encapsulation, repair and handling of asbestos-containing material is of great importance, because:
  - a. The inhalation of airborne asbestos fibers can cause a very serious and often fatal disease.
  - b. Workers may not be aware they are inhaling asbestos fibers.
  - c. Symptoms of the disease do not appear for many years.
  - d. Only the Contractor and its employees can prevent the inhalation of asbestos fibers, which can lead to the development of asbestos-related disease.
  - e. No insurance is available to provide for asbestos-related disease.

**E. Other Hazardous Material**

1. Contractor shall comply with OSHA 29 CFR 1926.62 - Lead in Construction when demolishing any equipment or architectural component identified as lead-containing or lead-based paint. The work of this project is considered a demolition activity.
2. the Owner anticipates that a substantial amount of the Project will involve lead paint.

**F. Qualifications**

1. the Owner and the Owner's Representative will verify and approve the experience of the Asbestos Abatement Contractor based upon submission at the time of bidding by Contractor evidence of the following:
  - a. Experience: Provide the names and locations of at least three asbestos abatement projects of comparable size and complexity comparable with this work. Provide the names and telephone numbers of contact person at previous projects. Provide the final air monitoring decontamination fiber levels achieved.



- b. Personnel: Provide the name(s) of "Competent Person" as defined by OSHA 29 CFR 1926.32(f) - Asbestos. Demonstrate the education and specialized training with successful completion of examination of an EPA approved course. Provide evidence of participation in five projects of complexity comparable with this project.
- c. Licensing and Certification: The Contractor must hold a current, valid asbestos license issued by the State in which the work is to be performed.

G. Notices And Record Keeping

1. Contractor shall maintain for at least 30 years, a record for each asbestos project in which the Contractor engages. Each record shall include the following information: name, address, and social security number of all personnel involved with the project, the name address and social security number of the OSHA "Competent Person" who will supervise the work, the amount of asbestos material that was removed, repaired, encapsulated or disturbed, the commencement and completion date of the work, copies of Hazardous Waste Manifest(s), personal air monitoring results and any other appropriate information.
2. The Contractor shall send written notification as required by USEPA National Emission Standards for Hazardous Air Pollutants (NESHAPS) Asbestos Regulations (40 CFR 61, Subpart M) to the Owner, at least 10 working days prior to beginning any work on asbestos-containing materials.
3. Include the following information:
  - a. Name and address of the Owner or operator.
  - b. Description of the facility being demolished or renovated, including the size, age, and prior use of the facility.
  - c. Estimate of the approximate amount of asbestos material present in the facility in terms of linear feet of pipe, and surface area on other facility components. For facilities in which the amount of asbestos materials is less than 80 linear meters (260 linear feet) on pipes and less than 15 square meters (160 square feet) on other facility components, explain techniques of estimation.
  - d. Location of the facility being demolished or renovated.
  - e. Scheduled starting and completion dates of demolition or renovation.
  - f. Nature of planned demolition or renovation and method(s) to be used.
  - g. Procedures to be used to comply with the requirements of USEPA National Emission Standards for Hazardous Air Pollutants (NESHAPS) Asbestos Regulations (40 CFR 61 Subpart M).
  - h. Name and location of the waste disposal site where the asbestos waste material will be deposited.
4. Prior to commencement of work, the Contractor shall submit the following documents to the Owner's Representative. No work will be allowed to start until these documents have been approved:
  - a. The schedule of the work, including manpower, length and number of work shifts. Schedule shall be coordinated with the Owner's full occupancy of all areas of the building.
  - b. Satisfactory proof that written notification has been provided to the EPA regional office and the Owner.
  - c. Proof that all required permits, disposal site locations, and arrangements for transportation and disposal of asbestos-contaminated materials, supplies and the like have been obtained.
  - d. Complete a worker certificate indicating that all employees have had instruction and training on the hazards of asbestos exposure, the use and fitting of respirators, protective dress, wet and dry decontamination procedures, entry and exit from work areas, and all aspects of work procedures and protective measures.
  - e. Documentation indicating that all employees have received appropriate medical examinations and have successfully passed fit testing for the respirator to be worn. As a minimum, medical exams must be consistent with OSHA 29 CFR 1926.1101(K)(9)(viii)(G)-Asbestos Regulation.



- f. Samples of signs to be used in and around the work area to comply with OSHA 29 CFR 1926.1101(K)(9)(viii)(I)- Asbestos regulations and as required by federal, state and municipal regulations.
  - g. Material Safety Data Sheets (OSHA form 174 or equivalent) for all chemicals used during work performed under this section.
  - h. Encapsulation data and encapsulation procedures.
  - i. Design of pressure differential system including calculation used to arrive at the number of machines necessary to achieve one air change per every 10 minutes.
  - j. Location of personnel and material decontamination units for each work area.
5. Contractor shall provide written notification to the Owner's Representative of its intent to start work at least five days in advance. In no case will the Contractor start work until authorization to proceed is given.
  6. During the work, Contractor shall maintain a daily log which will be kept at the job site. Items to be included in the daily log shall include but are not limited to the following:
    - a. Meetings, purpose, attendees, discussions, items of resolution.
    - b. Visitations, authorized and unauthorized.
    - c. Sign-in sheets of all personnel entering and leaving the work area.
    - d. Special or unusual events (i.e., barrier breeching equipment failures).
    - e. Personal air monitoring results.
    - f. Two copies of the daily log are required for Project Closeout.
- H. Terminology (Definitions)
1. Abatement - Procedures to control fiber release from asbestos-containing materials. Includes removal, enclosure or encapsulation.
  2. Air Lock - A system for permitting ingress or egress without permitting air movement between any two adjacent areas consisting of two curtained doorways. The air lock must be maintained in an uncontaminated condition at all times.
  3. Air Monitoring; - The process of measuring the asbestos fiber content of a specific volume of air in a stated period of time using methods approved or recommended by OSHA, EPA, NIOSH or other method approved by the Owner or the Owner's Representative.
  4. Amended water - Water to which a surfactant has been added.
  5. Asbestos - A generic name given to a number of naturally occurring hydrated mineral silicates that possess a unique crystalline structure, are incombustible in air, and are separable into fibers. Asbestos includes the asbestiform varieties of Chrysotile (serpentine), Crocidolite (Riebeckite), Amosite (Cummingtonite-Grunente), Anthophyllite, Actinolite, and Tremolite.
  6. Asbestos-containing material (ACM) - Any material that contains more than 1 percent asbestos by weight as determined by Polarized Light Microscopy (PLM).
  7. Authorized Visitor - the Owner or its designated representative, or a representative of any regulatory or other agency having jurisdiction over the project.
  8. Class I - Asbestos work means activities involving the removal of thermal systems insulation (TSI) and surfacing ACM and PACM.
  9. Class II - Asbestos work means activities involving the removal of ACM which is not TSI or surfacing material. This includes, but is not limited to, the removal of asbestos-containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastics.
  10. Class III - Asbestos work means repair and maintenance operations where "ACM" including TSI and surfacing ACM and PACM is likely to be disturbed.
  11. Class IV - Asbestos work means maintenance and custodial activities during which employees contact but do not disturb ACM or PACM and activities to clean-up dust, waste and debris resulting from Class I, II and III activities.
  12. Critical Barrier - A unit of temporary construction which provides the only separation between an asbestos work area and an adjacent, potentially occupied, space. The critical barrier is composed of at least one intact sheet of polyethylene sheeting.
  13. Decontamination Enclosure System - A series of connected rooms with curtained doorways between any two adjacent rooms, for the decontamination of workers or of materials and equipment. A decontamination system contains at least two air locks.



14. Disposal - All procedures necessary to transport and deposit the asbestos-contaminated material stripped and removed from the building in a waste disposal site in compliance with applicable federal, state, and local regulations.
15. Disposal Site - A site approved by the EPA for the disposal of asbestos-containing wastes.
16. Encapsulant - A liquid which can be applied to asbestos-containing materials and which controls the possible release of fibers from the materials.
17. Encapsulation - The use of an agent to seal the surface (bridging encapsulant) or penetrate the bulk (penetrating encapsulant) of the asbestos-containing material.
18. HEPA -High Efficiency Particulate Air - A type of filter which is 99.97% efficient at filtering particles of 0.3 micrometers in diameter.
19. HEPA Vacuum Equipment - Vacuuming equipment equipped with a HEPA filter in the exhaust outlet, and so designed and maintained that 99.97% of all particles of 0.3 micrometer in diameter in the inlet air are collected and retained.
20. Negative Pressure Respirators - Respirators which function by the wearer breathing in air through a filter.
21. NIOSH - National Institute of Occupational Safety and Health.
22. the Owner's Representative - Authorized Consultants
23. Permissible Exposure Level (PEL) - A level of airborne fibers specified by OSHA as an occupational exposure standard for asbestos. It is 0.1 f/cc of air, eight-hour TWA, as measured by Phase Contrast Microscopy.
24. Repair - The restoration of damaged or deteriorated asbestos-containing material to intact condition.
25. Respirator Protection Program - A set of procedures and equipment required by OSHA if employees wear negative pressure respirators or if fiber levels are above the PEL.
26. Surfactant - Chemical wetting agent added to water to improve penetration, thus reducing the amount of water required for a given operation or area, and enhancing the effect of the water in reducing fiber release.
27. Thermal Systems Insulation - Material applied to pipes, fittings, boilers, breeching, tanks, ducts or other interior structural components to prevent heat loss or gain, or water condensation, or for other purposes.
28. Wet Cleaning - The process of eliminating asbestos contamination from building surfaces and objects by using cloths and mops or other cleaning tools that have been dampened with clean water and afterwards disposing of these cleaning tools as asbestos-contaminated waste.

I. Permits And Licenses:

1. The Contractor must maintain current licenses as required by applicable state or local jurisdictions for the removal, transporting, disposal or other regulated activity relative to the work of this contract.

J. Regulations

1. This section sets forth governmental regulations and industry standards which are included and incorporated herein by reference and made a part of the specifications. This section also sets forth those notices and permits which are known to the Owner and which either must be applied for and received, or which must be given to governmental agencies before start of work.
2. Except to the extent that more explicit or more stringent requirements are written directly into the contract documents, all applicable codes, regulations, and standards have the same force and effect (and are made a part of the contract documents by reference) as if copied directly into the contract documents, or as if published copies are bound herewith.
3. The Contractor shall assume full responsibility and liability for the compliance with all applicable federal, state, and local regulations pertaining to work practices, hauling, disposal, and protection of workers, visitors to the site, and persons occupying areas adjacent to the site. The Contractor is responsible for providing medical examinations and maintaining medical records of personnel as required by the applicable federal, state, and local regulations. The Contractor shall hold the Owner and the Owner's Representative harmless for failure to comply with any applicable work,



- hauling, disposal, safety, health or other regulation on the part of itself, its employees, or its Sub-Contractors.
4. Federal requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials include but are not limited to the following regulations:
    - a. U.S. Department of Labor, Occupational Safety and Health Administration, (OSHA), including but not limited to:
      - 1) U.S. Department of Labor, OSHA, including, but not limited to:
        - a) Occupational Exposure to Asbestos, Tremolite, Anthophyllite and Actinolite; Final Rules  
Title 29, Part 1910, Section 1001  
Part 1926, Section 1101 of the Code of Federal Regulations
        - b) Respiratory Protection  
Title 29, Part 1910, Section 134 of the Code of Federal Regulations
        - c) Construction Industry  
Title 29, Part 1926.1011, of the Code of Federal Regulation
        - d) Access to Employee Exposure and Medical Records  
Title 29, Part 1910, Section 2 of the Code of Federal Regulations
        - e) Hazard Communication  
Title 29, Part 1910, Section 1200 of the Code of Federal Regulations
        - f) Specifications for Accident Prevention Signs and Tags  
Title 29, Part 1910, Section 145 of the Code of Federal Regulations
      - 2) U.S. Environmental Protection Agency (EPA) including, but not limited to:
        - a) Asbestos Abatement Projects Rule  
40 CFR Part 762  
CPTS 62044, FRL 2843-9  
Federal Register, Vol. 50 No. 134, July 12, 1985  
P28530-28540
        - b) Regulation for Asbestos  
Title 40, Part 61, Subpart A of the Code of Federal Regulations
        - c) National Emission Standard for Asbestos  
Title 40, Part 61, Subpart M (Revised Subpart B) of the Code of Federal Regulations
      - 3) State requirements which govern asbestos abatement work and/or hauling and disposal of asbestos waste materials.
      - 4) Contractor shall abide by all local requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials including the following:
        - a) American National Standards Institute (ANSI)  
1430 Broadway  
New York, NY 10018  
(212) 354-3300
        - b) Fundamentals Governing the Design and Operation of Local Exhaust Systems  
Publication Z9.2-79
        - c) Practices for Respiratory Protection Publication Z288.2-80
        - d) American Society for Testing and Materials (ASTM)  
1916 Race Street  
Philadelphia, PA 19103  
(215) 299-5400
        - e) Specification for Encapsulants for Friable Asbestos-Containing Building Materials
        - f) Safety and Health Requirements Relating to Occupational Exposure to Asbestos

K. the Owner's Representative

1. the Owner's Representative is authorized by the Owner to perform the following:
  - a. Have free access to all asbestos work areas.



- b. To assist in interpretation of procedures.
- c. To advise on all provisions of the contract documents pertaining to the control of asbestos.
- d. To stop work if, in the course of performing their monitoring duties, an instance of substantial nonconformance with the contract documents is observed.
- e. To stop work if a situation presenting a health hazard to workers or the Owner's employees or occupants of the building is observed.
- f. To act as the Owner's liaison in technical matters involving the asbestos-related work.
- g. To perform air sampling inside and outside the asbestos work area during the project. The Contractor shall cooperate fully with the Owner's Representative, its agents and employees, and ensure cooperation of its workers during collection of air samples and work area inspections.
- h. the Owner's Representative role in advising the Owner on environmental health matters does not relieve the Contractor's obligation to comply with all applicable health and safety regulations. Air monitoring results generated by the Owner's Representative shall not be used by the Contractor to represent compliance with regulatory agency requirements for monitoring of worker's exposure to airborne asbestos, nor shall any other activity on the part of the Owner's Representative represent the Contractor's compliance with applicable health and safety regulations.

#### L. Pre-Construction Conference

1. An initial progress meeting recognized as "Pre-Construction Conference" shall be held prior to start of any work. Contractor shall meet at project site, with General Superintendent, the Owner, the Owner's Representative, and other entities concerned with asbestos abatement work. Record discussions and agreements and furnish copy to each participant. Provide at least 72 hours advance notice to all participants prior to convening Pre-Construction Conference.
2. This is an organizational meeting, to review responsibilities and personnel assignments, to locate the containment and decontamination areas; and temporary facilities including power, light, water, etc.
3. Submit waivers on forms, and executed in a manner acceptable to the Owner. Administrative requirements that must proceed or coincide with Contractor's submittal for final payment shall consist of the following:
  - a. Completion of project closeout requirements.
  - b. Completion of items specified for completion beyond time of Final Completion (regardless of whether special payment application was previously made).
  - c. Assurance, satisfactory to the Owner, that unsettled claims will be settled and that work not actually completed and accepted will be completed without undue delay.
  - d. Transmittal of required project construction records to the Owner.
  - e. Landfill receipts for all asbestos-containing material.
  - f. Proof, satisfactory to the Owner, that taxes, fees and similar obligations of Contractor have been paid.
  - g. Removal of temporary facilities, services, surplus materials, rubbish and similar elements.
  - h. Consent of surety for final payment.

#### M. Project Closeout

1. Project closeout is the term used to describe certain collective project requirements that indicate completion of the work to be fulfilled near the end of the contract time. Also, in preparation for final acceptance of the work by the Owner, as well as, final payment to the Contractor and the normal termination of the Contract.
2. Include supporting documentation for completion as indicated in these contract documents.
3. Submit a statement on accounting of changes to the Contract Sum.
4. Advise the Owner of pending insurance change-over requirements.
5. Submit specific warranties, workmanship and maintenance bonds, maintenance agreements, final certifications and similar documents.



6. Obtain and submit releases enabling the Owner's full, unrestricted use of the work area and access to services and utilities. Where required, include occupancy permits, operating certificates and similar releases.
7. Results of the completed inspection will form the initial "punch-list" for final acceptance.
8. A complete record, certified by the testing laboratory, of all personal air monitoring results.
9. Complete the following cleaning operations as outlined in Paragraph "Decontamination Procedures" before requesting the Owner's Representative inspection for certification of Final Completion.
  - a. Remove exposed labels in finished spaces which are not required as permanent labels on materials supplied as part of the work, except for "Asbestos", "Asbestos Free", or Thermal Insulation Labels specified elsewhere.
  - b. Clean transparent materials, affected by the work including mirrors and window/door glass, to a polished condition, removing substances which are noticeably vision-obscuring materials. Replace broken glass and damaged transparent materials.
  - c. Clean exposed hard-surfaced finishes affected by the work, to a dirt-free condition, free of dust, stains, films and similar distracting substances. Except as otherwise indicated, avoid disturbance of natural weathering of exterior surfaces. Restore reflective surfaces to original reflective condition.
  - d. Clean plumbing fixtures affected by the work to a sanitary condition, free of stains including those resulting from water exposure.
  - e. Replace all HVAC filters using materials supplied by the Owner or clean non-replaceable filters after minimum of two days of operation of HVAC equipment.
  - f. Clean light fixtures and lamps, which have been affected by the work so as to function with full efficiency. Replace lamps where inoperable.
  - g. Repair any damage to wall, ceiling and floor surfaces caused by installation and removal of the polyethylene sheeting.

#### N. Personnel Protection

1. Prior to commencement of work, the workers shall be instructed and be knowledgeable in the areas described in Paragraph "Submittals and Notices" having to do with employees.
2. Worker Protection - shall comply with 29 CFR 1910.134 (Respiratory Protection).
  - a. Because there is no known safe level of exposure to asbestos, it is prudent to reduce worker's exposures to as low a level as possible. Proper respiratory protection is critical in minimizing exposure.
  - b. Workers shall be provided, as a minimum, with personally issued and marked respirators equipped with high efficiency particulate filters approved by NIOSH to be worn in the designated work area and/or whenever a potential exposure to asbestos exists. Sufficient filters shall be provided for replacement as required by the workers or applicable regulations. Disposable respirators shall not be used.
  - c. No worker shall be exposed to levels greater than 0.01 f/cc as determined by the protection factor of the respirator worn and the work area fiber levels.
  - d. Whenever powered purifying respirator protection is used, a sufficient supply of replacement batteries and HEPA filter cartridges shall be provided to the workers.
  - e. Air monitoring required by OSHA is work of the Contractor and not covered in this specification. Contractor shall post, on a daily basis, results of the air monitoring results from the previous shift. A complete record, certified by the testing laboratory, of all personal air monitoring tests and results will be furnished to the Owner and the Owner's Representative prior to Contractor's Request for Final Payment.
  - f. During encapsulation operations or usage of other organic base aerosols (e.g., spray glue, expanding foam), workers shall be provided with combination cartridges consisting of organic vapor and HEPA sections.
  - g. Workers shall be provided with sufficient sets of protective full-body clothing to be worn in the designated work area and/or whenever potential exposure to asbestos exists. Such clothing shall include, but not be limited to, full-body coveralls, headgear and gloves. Workers shall assure that hoods covering their hair are worn in the designated work areas



- at all times. Eye protection and hard hats shall be provided as required by applicable safety regulations. Eye protection shall be worn during encapsulation operations. Non-disposable type protective clothing and footwear shall be left in the work area until the end of the asbestos abatement work, at which time such items will be disposed of as asbestos waste.
- h. Non-skid footwear shall be provided to all abatement workers. Disposable clothing shall be adequately sealed to the footwear to prevent body contamination.
  - i. Protective clothing shall not be worn in lieu of street clothing outside the work area.
  - j. Visitor Clothing: The Contractor shall provide authorized visitors with suitable respirator, protective clothing, headgear, eye protection, and footwear as described herein, whenever they enter the work area.
3. Decontamination and Work Procedures: The decontamination and work procedures to be followed by workers shall be posted as described in these specifications.
  4. Worker and Authorized Visitor Protection Procedures:
    - a. Each worker and authorized visitor shall, upon entering the job site, remove street clothes in a designated clean change area and put on a respirator with new filters and clean protective clothing before entering the work area.
    - b. The Contractor's employees shall perform a positive/negative respirator fit test each time it enters the work area. If leakage occurs, the respirator must be re-adjusted or replaced.
    - c. Workers shall maintain their respirators in a safe operating condition. The condition of respirators shall be checked daily.
    - d. Workers and visitors shall complete the decontamination procedures as outlined in the specification upon exiting the work area.
    - e. Workers shall not eat, drink, smoke, or chew gum or tobacco in or near the asbestos work areas.
    - f. Workers shall be fully protected with respirators and protective clothing immediately prior to the first disturbance of asbestos-containing or contaminated materials and until final cleanup is completed.
- O. Air Monitoring
1. The airborne fiber counts outside the work area will be monitored to detect faults in the work area isolation such as contamination of the building outside of the work areas with airborne asbestos fibers, failure of filtration or rupture in the negative pressure system. Should any of the above occur, the Contractor shall immediately cease asbestos abatement activities until the fault is corrected. Work shall not recommence until authorized by the Owner's Representative. In the case of mini-enclosures the Owner's Representative will monitor air in a remote location of the residence to determine the baseline of asbestos.
  2. The airborne fiber counts in the work area will be monitored. The purpose of this air monitoring will be to detect airborne fiber counts which may significantly challenge the ability of the work area isolation procedures to protect the balance of the building or outside of the building from contamination by airborne fibers. In the case of mini-enclosures the Owner's representative may monitor air outside of several enclosures if they are in close proximity.
  3. Contractor shall maintain an average airborne count inside the work area of less than 0.5 f/cc. If the fiber counts rise above this figure for any sample taken, revise work procedures to lower fiber counts. If the TWA fiber count for any work shift or eight-hour period exceeds 0.5 f/cc, stop all work, leave pressure differential system in operation and notify the Owner's Representative. Do not recommence work until authorized in writing by the Owner's Representative.
  4. If airborne fiber counts exceed 1.0 f/cc for any period of time cease all work until fiber counts fall below 0.5 f/cc and notify the Owner's Representative. Do not recommence work until authorized in writing by the Owner's Representative.
  5. If any air sample taken outside of the work area exceeds the 0.01 f/cc of air, Contractor shall immediately and automatically stop all work. If this air sample was taken inside the building and outside of critical barriers around the work area, immediately erect new critical barriers to isolate the affected area from the balance of the building. Erect Critical Barriers at the next existing structural isolation of the involved space (e.g., wall, ceiling, and floor). Leave Critical Barriers in



- place until completion of work and insure that the operation of the negative pressure system in the work area results in a flow of air from the balance of the building into the affected area.
6. If the exit from the clean room of the personnel decontamination unit enters the affected area, establish a temporary decontamination facility consisting of a shower room and changing room. After cleaning and decontamination of the affected area remove the shower room and leave the changing room in place as an air lock.
  7. After certification of visual inspection in the work area, remove critical barriers separating the work area from the affected area. Final air samples will be taken within the entire area.
  8. The following procedure will be used to resolve any disputes regarding fiber types when a project has been stopped due to excessive airborne fiber counts. "Airborne Fibers" referred to above include all fibers regardless of composition as counted in the Phase Contrast Microscopy (PCM) NIOSH 7400 Method procedures. If work has stopped due to high airborne fiber counts, air samples will be secured in the same area by the Owner's Representative for analysis by electron microscopy. "Airborne fibers" counted in samples analyzed by Scanning or Transmission Electron Microscopy (TEM) shall be only asbestos fibers, but of any diameter and length. Subsequent to analysis by Electron Microscopy the number of airborne fibers shall be determined by multiplying the number of fibers, regardless of composition, counted by the PCM NIOSH 7400 Method procedure by a number equal to asbestos fibers counted divided by all fibers counted in the electron microscopy analysis.
  9. If electron microscopy is used to arrive at the basis for determining airborne fiber counts in accordance with the above paragraph, and if the average of airborne asbestos fibers in all samples taken exceeds 0.1 f/cc, or if any one sample exceeds 0.2 f/cc, then the cost of such analysis will be born by the Contractor, at no additional cost to the Owner.
  10. the Owner's Representative will secure at least the following air samples to establish a base line before start of work involving large enclosures:

Location Sampled	Number of Samples	Analysis Method	Detection Limit f/cc	Minimum Volume Liters	Rate LPM
Each Work Area	1	PCM	0.01	1,900	2-16
Outside Each Work Area	1-3	PCM	0.01	1,900	2-16

11. Base Line is an action level expressed in f/cc, which is ten percent greater than the largest of the following:
  - a. Average of the samples collected on cellulose ester filters outside each work area.
  - b. Average of the samples collected on cellulose ester filters outside the building.
  - c. 0.01 fibers per cubic centimeter.
12. Daily: From start of work of Paragraph "Temporary Enclosure" through the work of Paragraph "Project Decontamination," the Owner may be taking the following samples on a daily basis. The location of each air sample will be determined by the Owner's Representative.
  - a. Baseline
  - b. Work Area
13. For larger enclosures samples will be collected on 25 mm cassettes with the following filter media:
 

PCM: 0.8 micrometer mixed cellulose ester.

Location Sampled	Number of Samples	Analysis Method	Detection Limit f/cc	Minimum Volume Liters	Rate LPM
Each Work Area	2	PCM	0.01	1,900 as required by conditions	2-16
Outside Each Work Area Critical Barrier	1	PCM	0.01	1,900	2-16
Clean Room	1	PCM	0.01	1,900	2-16
Equip Decon	1	PCM	0.01	1,900	2-16



14. Additional samples may be taken at the Owner or the Owner's Representative discretion. If airborne fiber counts exceed allowed limits, additional samples will be taken as necessary to monitor fiber levels.
15. The services of a testing laboratory will be employed by the Owner to perform laboratory analysis of the air samples. Samples will be sent daily so that verbal reports on air samples can be obtained in a timely manner. A complete record, certified by the testing laboratory, of all air monitoring tests and results will be furnished to the Owner's Representative, the Owner and the Contractor.
16. Air samples may be analyzed on site by the Owner's Representative, if they are to be analyzed by the NIOSH 7400 Method.
17. Cellulose ester filters will be analyzed using the PCM NIOSH 7400 Method. Thus analysis will be carried out at a laboratory located off the job site.
18. At the completion of the work in occupied areas and prior to the dismantling of the isolation system, final air clearance will be conducted by the Owner's Representative.
19. Decontamination of the work area will be considered complete when all samples indicate fiber levels are less than 0.01 f/cc of air as analyzed by PCM NIOSH 7400 Method or an average of less than 70 structures per square millimeter of filter area as analyzed by TEM; Level II AHERA Method.
20. The Contractor may conduct its own air monitoring and laboratory testing. If it elects to do this the cost of such air monitoring and laboratory testing shall be included in the Contract Sum.

P. Equipment Removal Procedures

1. Clean all external surfaces of contaminated waste containers and equipment thoroughly by wet sponging or HEPA vacuuming before moving such items into the equipment decontamination enclosure system washroom for final cleaning and removal to uncontaminated areas. Ensure that personnel do not leave the work areas through the equipment decontamination enclosure system.

Q. Disposal Activities

1. It is the responsibility of the Contractor to comply with current federal, state and local regulations concerning the waste handling, transportation, and disposal of asbestos-containing material (ACM) and accompanying solvents or residues.
2. The Contractor will document actual disposal of the waste at the designated landfill by completing Disposal Certificate or submitting proof of landfill receipt.

## 1.2 PRODUCTS

A. Materials

1. All Contractor's equipment delivered to the site shall be free of asbestos contamination.
2. Store all materials subject to damage off the ground, away from wet or damp surfaces, and under cover sufficient to prevent damage or contamination.
3. Damaged or deteriorating materials shall not be used and shall be removed from the premises. Materials that become contaminated shall be disposed of in accordance with applicable regulations.
4. Polyethylene flame retardant sheet of 6-mil thickness shall be used unless otherwise specified. Polyethylene sheeting shall be sized to minimize the frequency of joints. Polyethylene sheeting must satisfy the National Fire Prevention Association Standard 701, "Small Scale Fire Test for Flame Resistant Textile and Film."
5. Adhesive tape shall be capable of sealing joints of adjacent sheets of polyethylene and for use in attachment of polyethylene sheet to finished or unfinished surfaces of similar materials and shall be capable of adhering under dry and wet conditions, including use of amended water. Contractor shall use adhesive tape compatible with finished surfaces.



6. Protective devices such as, but not limited to, disposable clothing, respirators, gloves, hard hats, etc. shall be used.
7. Wetting agent shall be a mixture of 50/50 polyoxyethylene ether and polyglycol ester or equivalent commercial product.
8. Encapsulant materials shall be the bridging and penetrating type and conform with the following characteristics:
  - a. Encapsulants shall not be solvent-based or utilize a hydrocarbon in the liquid in which the solid parts of the encapsulant are suspended.
  - b. Encapsulant shall not be flammable.
9. A non-hardening lagging sealer for enclosing and sealing raw exposed edges and surfaces of asbestos-containing materials.
10. Pre-mixed or job mixed insulating plaster manufactured for use on plumbing equipment shall be used when repairing damaged thermal insulation material.
11. Non-woven fibrous glass mat and open weave glass fiber mat cloth for repair of thermal systems insulation.
12. Fire retardant sealant shall prevent fire, smoke, water and toxic fumes from penetrating through sealants. Sealant shall have a flame spread, smoke and fuel contribution of zero, and shall be ASTM and Underwriter's Laboratory (UL) rated for three hours for standard method of fire test for fire stop systems.

B. Tools And Equipment

1. Provide suitable tools for repair and encapsulation of asbestos-containing materials and for removal of asbestos-containing materials that are beyond repair. Wire brushes shall not be used as a means of removing or cleaning asbestos-containing materials from surfaces, if they are used as the surface is being sprayed with water or amended water.
2. Provide sufficient number of HEPA-filtered vacuum cleaners equipped with pick-up adapters, steel floor wands, crevice tools, and carpet tools.
3. Airless sprayers capable of spraying amended water shall be provided in sufficient number to allow continuous uninterrupted work.
4. Asbestos filtration devices shall utilize high efficiency particulate air (HEPA) filtration systems.
5. Transportation equipment, as required, shall be suitable for loading, temporary storage, and unloading of contaminated waste without exposure to persons or property, and shall be quiet in motion if used within the building.

### 1.3 EXECUTION

A. Safety Procedures For Power And Lighting

1. The use of wet methods for removal, repair, encapsulation or cleaning procedures increases the potential for electrical shock when working around electrical panels, conduit, light fixtures, alarm systems, junction boxes, transformers, etc. In coordination with the Owner, de-energize as much electrical equipment as possible to prevent electrical shock to employees performing the work. The Contractor shall use the following precautions:
  - a. Use non-conductive tools and vacuum attachments.
  - b. Utilize "hot line" covers over energized cables and power lines when possible.
  - c. Ensure all electrical equipment in use is properly grounded before the job starts. Check outlets, wiring, extension cords and power pickups.
  - d. Avoid stringing wiring across floors. Elevate wiring if possible.
  - e. Ensure electrical outlets are tightly sealed and taped to avoid water spray.
  - f. Determine operating voltages of equipment and lines before working on or near energized parts.
  - g. Energized parts must be insulated or guarded from employee contact and other conductive objects. Extension cords must be three-wire type and connected to a Ground Fault Interrupter (GFI) circuit.
  - h. Lock or secure de-energized circuits at panel and post warning signs.



- i. Seal heating vents with two layers of polyethylene sheeting prior to the start of work. The Contractor shall repair any damage caused by Contractor's operations to duct work, grilles, dampers, louvers or HVAC equipment at the completion of the work at Contractor's expense. Coordinate all lock out and or de-energizing with the Owner.

B. Temporary Facilities

1. Use qualified tradesmen for installation of temporary services and facilities. Locate temporary services and facilities where they will serve the entire project adequately and result in minimum interference with the performance of the work and operations of the building. Coordinate all installations and shut downs with building owner.
2. Relocate, modify and extend services and facilities as required during the course of work so as to accommodate the entire work of the project.
3. Provide new or used materials and equipment that are undamaged and in serviceable condition. Provide only materials and equipment that are recognized as being suitable for the intended use, by compliance with appropriate standards.
4. During the erection and/or moving of scaffolding, care must be exercised so that the polyethylene floor covering is not damaged.
5. Clean, as necessary, debris from non-slip surfaces.
6. At the completion of abatement work, clean all construction aids within the work area, wrap in one layer of 6-mil polyethylene sheet and seal before removal from the work area.
7. Temporary water service connections to the Owner's water system shall include back flow protection. Valves shall be temperature and pressure rated for operation of the temperatures and pressures encountered.
8. Employ heavy-duty abrasion-resistant hoses with a pressure rating 50 percent greater than the maximum pressure of the water distribution system to provide water into each work area and to each Decontamination Unit. Provide fittings as required to allow for connection to existing wall hydrants or spouts, as well as temporary water heating equipment, branch piping, showers, shut-off nozzles and equipment.
9. Electrical Services shall comply with applicable NEMA, NECA and UL standards and governing regulations for materials and layout of temporary electric service.
10. Provide a weatherproof, grounded temporary electric power service and distribution system of sufficient size, capacity, and power characteristics to accommodate performance of work during the construction period. Install temporary lighting adequate to provide sufficient illumination for safe work and traffic conditions in every area of work.
11. Provide receptacle outlets equipped with ground fault interrupters, reset button and pilot light, for plug-in connection of power tools and equipment.
12. Use only grounded extension cords; use "hard-service" cords where exposed to abrasion and traffic. Use single lengths or use waterproof connectors to connect separate lengths of electric cords, if single lengths will not reach areas of work. All cords shall be elevated off the floor inside the containment area.
13. Temporary wiring in the work area shall be type UL non-metallic sheathed cable located overhead and exposed for surveillance. Do not wire temporary lighting with plain, exposed (insulated) electrical conductors. Provide liquid tight enclosures or boxes for wiring devices.
14. Provide Type "A" fire extinguishers for temporary offices and similar spaces where there is minimal danger of electrical or grease-oil-flammable liquid fires. In other locations provide type "ABC" dry chemical extinguishers, or a combination of several extinguishers of NFPA recommended types for the exposures in each case.
15. Use of the Owner's existing toilet facilities, as indicated, will be permitted, so long as these facilities are properly cleaned and maintained in a condition acceptable to the Owner. At Final Completion, restore these facilities to the condition prevalent at the time of initial use. All provisions of these specifications regarding leaving the work area must be met.
16. When mini-enclosures area being used all of the requirements above will be enforced by the Owner's Representative. The construction and set-up of the mini-enclosures may be done by the Abatement Contractor.



- C. Pressure Differential System
1. Before start of work Contractor shall submit design of pressure differential system to the Owner's Representative for review. Do not begin work until system has been approved by the Owner's Representative. Include in the submittal the following:
    - a. Number of pressure differential machines required and the calculations necessary to determine the number of machines.
    - b. Description of projected air-flow within work area and methods required to provide adequate air flow in all portions of the work area.
  2. If the enclosure is not a mini-enclosure, the Contractor must supply the required number of asbestos air filtration units to the site in accordance with these specifications. Each unit shall include the following:
    - a. Cabinet constructed of steel or other durable materials able to withstand damage from rough handling and transportation. The width of the cabinet should be less than 30 inches to fit through standard-size doorways. Cabinet shall be factory sealed to prevent asbestos-containing dust from being released during use, transport, or maintenance. Access to and replacement of all air filters shall be from intake end. Unit shall be mounted on casters or wheels.
    - b. Rate capacity of fan according to useable air-moving capacity under actual operating conditions. Use centrifugal-type fan.
    - c. The final filter shall be the HEPA type. The filter media (folded into closely pleated panels) must be completely sealed on all edges with a structurally rigid frame.
    - d. A continuous rubber gasket shall be located between the filter and the filter housing to form a tight seal.
    - e. Provide HEPA Units that are individually tested and certified on site by an independent testing agency to have an efficiency of not less than 99.97 percent when challenged with 0.3 m dioctylphthlaate (DOP) particles when tested in accordance with Military Standard Number 2182 and Army Instruction Manual 136-300-175A. Provide filters that bear a UL586 label to indicate ability to perform under specified conditions.
    - f. Pre-filters, which protect the final filter by removing the larger particles, are required to prolong the operating life of the HEPA filter. Two stages of pre-filtration are required. The first-stage pre-filter shall be a low-efficiency type (e.g., for particles 10 microns and larger). The second-stage (or intermediate) filter shall have a medium efficiency (e.g., effective for particles down to 5 microns). Pre-filters and intermediate filters shall be installed either on or in the intake grid of the unit and held in place with special housings or clamps.
    - g. Each unit shall be equipped with a Magnahelic gauge or manometer to measure the pressure drop across filters and indicate when filters have become loaded and need to be changed. A table indicating the useable air-handling capacity for various static pressure readings on the Magnahelic gauge shall be affixed near the gauge for reference, or the Magnahelic reading indicating at what point the filters should be changed, noting Cubic Feet per Minute (CFM) air delivery at that point. Provide units equipped with an elapsed time meter to show the total accumulated hours of operation.
    - h. The unit shall have an electrical (or mechanical) lockout to prevent fan from operating without a HEPA filter. Units shall be equipped with automatic shutdown system to stop fan in the event of a major rupture in the HEPA filter or blocked air discharge. Warning lights are required to indicate normal operation, too high a pressure drop across the filters (i.e., filter overloading), and too low of a pressure drop (i.e., major rupture in HEPA filter or obstructed discharge).
    - i. Electrical components shall be approved by the National Electrical Manufacturers Association (NEMA) and Underwriters' Laboratories (UL). Each unit shall be equipped with overload protection sized for the equipment. The motor, fan, fan housing, and cabinet shall be grounded.
    - j. If a mini-enclosure is used the air filtration unit may be a HEPA filtered vacuum with a flow rate of at least 100 cubic feet per minute (CFM).
  3. Provide a fully operational pressure differential system within the work area maintaining continuously a pressure differential across work area enclosures of 0.02 inches of water for glove



- bag operations and mini-containments. Demonstrate to the Owner's Representative the pressure differential by use of pressure differential meter or a manometer, before disturbance of any asbestos-containing materials. In the case of a mini-enclosure visual evidence of pressure differential through the use of a smoke generation tube shall be sufficient as in paragraph C.13 of this section.
4. Continuously monitor and record the pressure differential between the work area and the building outside of the work area.
  5. Provide fully operational negative pressure systems supplying a minimum of one air change every ten minutes (six changes per hour), less in the instance of a mini-enclosure. Determine the volume in cubic feet of the work area by multiplying floor area by ceiling height. Determine total ventilation requirement in cubic feet per minute (cfm) for the work area by dividing this volume by the air change rate.
  6. Ventilation Required (CFM) = Volume of work area (cu. ft.)/10 min.
  7. Determine number of units needed to achieve ten-minute change rate by dividing the ventilation requirement (CFM) above capacity of exhaust unit(s) used. Capacity of a unit for purposes of this section is the capacity in cubic feet per minute with fully loaded filters (pressure differential which causes loaded filter warning light to come on) in the machines labeled operating characteristics.
  8. Add one additional unit as a backup in case of equipment failure or machine shutdown for filter changing.
  9. Locate exhaust unit(s) so that makeup air enters work area primarily through decontamination facilities and traverses work area as much as possible. This may be accomplished by positioning the unit(s) at a maximum distance from the worker access opening or other makeup air sources.
  10. Vent to outside of building, unless authorized in writing by the Owner's Representative.
  11. Each unit shall be serviced by a dedicated minimum 115v-20A circuit with overload device tied into an existing building electrical panel which has sufficient spare capacity to accommodate the load of all pressure differential units connected. Dedication of an existing circuit may be accomplished by shutting down existing loads on the circuit.
  12. Test pressure differential system before any asbestos-containing material is wetted or removed. After the work area has been prepared, the decontamination facility set up, and the exhaust unit(s) installed, start the unit(s) (one at a time). Demonstrate operation and testing of pressure differential system to the Owner's Representative.
  13. Demonstrate of operations of the pressure differential system to the Owner's Representative will include, but not be limited to, the following:
    - a. Plastic barriers and sheeting move lightly in toward work area.
    - b. Curtain of decontamination units move lightly in toward work area.
    - c. There is a noticeable movement of air through the decontamination unit. Use stroke tube to demonstrate air movement from clean room, and from equipment room to work area.
    - d. Use smoke tubes to demonstrate a positive motion of air across all area in which work is to be performed.
    - e. Use a differential pressure meter or manometer to demonstrate a pressure difference of at least 0.02 inches (as allowed) of water across every barrier separating the work area from the balance of the building or outside. This is not required in the case of a mini enclosure.
  14. Start exhaust units before beginning work (before any asbestos-containing material is disturbed). After abatement work has begun, run units continuously to maintain a constant negative pressure until decontamination of the work area is complete. Do not turn off units at the end of the work shift or when abatement operations temporarily stop.
  15. Do not shut down pressure differential system during encapsulating procedures, unless authorized by the Owner's Representative in writing. Start abatement work at a location farthest from the exhaust units and proceed toward them. If an electric power failure occurs, immediately stop all abatement work and do not resume until power is restored and exhaust units are operating again.
  16. At completion of abatement work, allow exhaust units to run as specified to remove airborne fibers that may have been generated during abatement work and cleanup and to purge the work area with clean makeup air. The units may be required to run for a longer time after decontamination, if



dry or only partially wetted asbestos material was encountered during any abatement work. In the case of a mini-enclosure the vacuum may be removed and the entrance sealed following encapsulation until the clearance sample is collected.

- 17. Prior to final air test, remove pre-filter and wipe out inside lip of negative air machine.
- 18. When a final inspection and the results of final air tests indicate that the area has been decontaminated, exhaust units may be removed from the work area. Before removal from the work area, remove and properly dispose of pre-filter, and seal Intake to the machine with 6-mil polyethylene to prevent environmental contamination from the filters.

D. Work Area Preparation

- 1. The work area is the location where asbestos-abatement work occurs. It is a variable of the extent of work of the contract. It may be a portion of a room, a single room, or a complex of rooms. A "work area" is considered contaminated during the work, and must be isolated from the balance of the building, and decontaminated at the completion of the asbestos-control work.
- 2. Pre-clean fixed objects, walls and floor surfaces within the proposed work areas using HEPA filtered vacuum equipment and wet cleaning methods as appropriate.
- 3. Seal all openings, supply and exhaust vents, and convectors within ten feet of the work area with 6-mil polyethylene sheeting secured and completely sealed with plastic adhesion tape.
- 4. Contact fire control agencies to review procedures prior to start of work.
- 5. Provide flame resistant polyethylene sheeting that conforms to requirements set forth by the National Fire Protection Association Standard 701, Small Scale Fire Test for Flame-resistant Textiles and Films. Provide largest size possible to minimize seams, four- or six- mils thick, frosted or black.
- 6. Provide spray adhesive in aerosol cans which is specifically formulated to stick tenaciously to sheet polyethylene and supporting surface.
- 7. Completely isolate the work area from other parts of the building so as to prevent asbestos-containing dust or debris from passing beyond the isolated area. Should the area beyond the work area(s) become contaminated with asbestos-containing dust or debris as a consequence of the work, clean those areas in accordance with the procedures indicated in Paragraph "Decontamination Procedures." All such required cleaning or decontamination shall be performed at no additional cost to the Owner.
- 8. Place all tools (i.e., scaffolding, staging) necessary for the work in the area to be isolated prior to erection of plastic sheeting temporary enclosure.
- 9. Disable ventilation systems or any other system bringing air into or out of the work area. Disable system by disconnecting wires, removing circuit breakers, by lockable switch or other positive means that will prevent accidental premature restarting of equipment.
- 10. Remove and dispose of all electrical and mechanical items, such as lighting fixtures, clocks, diffusers, registers, escutcheon plates, etc., which cover any part of the surface on which work is to be performed.
- 11. All general construction items such as cabinets, casework, doors and window trim, moldings, ceilings, trim, etc., which cover the surface of the work as required to prevent interference with the work. To be performed by the Owner: clean, decontaminate and reinstall all such materials, upon completion of all removal work with materials, finishes, and workmanship to match existing installations before start of work.
- 12. Permit Access to the work area only through the Decontamination Unit. All other means of access shall be closed off and sealed and warning signs displayed on the clean side of the sealed access.
- 13. Provide Warning Signs at each visual and physical barriers reading as follows in both English and Spanish:

<u>Legend</u>	<u>Notation</u>
KEEP OUT	3" Sans Serif Gothic or Block
BEYOND THIS POINT	1" Sans Serif Gothic or Block
ASBESTOS ABATEMENT WORK	1" Sans Serif Gothic or Block



IN PROGRESS  
BREATHING ASBESTOS DUST MAY BE  
HAZARDOUS TO YOUR HEALTH

1" Sans Serif Gothic or Block  
14 Point Gothic

14. Alternate methods of containing the work area may be submitted to the Owner's Representative for approval. Do not proceed with any such method(s) without prior written approval of the Owner's Representative.
15. Individually seal all ventilation openings (supply and exhaust), lighting fixtures, clocks, doorways, windows, convectors and speakers, and other openings into the work area with plastic adhesion tape alone or with polyethylene sheeting at least 4-mil in thickness, taped securely in place with plastic adhesion tape. Maintain seal until all work including Project Decontamination is completed. Take care in sealing off lighting fixtures to avoid melting or burning of sheeting.
16. Provide sheet plastic barriers at least 6-mil in thickness as required to completely seal openings from the work area into adjacent areas. Seal the perimeter of all sheet plastic barriers with plastic adhesion tape or spray cement.
17. Where applicable, construct framing of the containment out of fire treated wood or aluminum studs. Mini-enclosure frames may be constructed of Polyvinyl Chloride (PVC) tubing.
18. Cover all walls in work area extending to the underside of the ceiling grid system with one layer of polyethylene sheeting, at least 6-mil in thickness, mechanically supported and sealed with plastic adhesion tape or spray-glue in the same manner as "Critical Barrier" sheet plastic barriers. Tape all joints with plastic adhesion tape. Contractor shall be responsible for repair of damaged wall finishes.
19. Cover floor with two layers of 6-mil polyethylene sheeting (exclude for floor tile and adhesive).
20. Provide Pressure Differential System per Paragraph "Pressure Differential System."
21. If the enclosure barrier is breached in any manner that could allow the passage of asbestos debris or airborne fibers, then add the affected area to the work area, enclose it as required by this section of the specification and decontaminate it as described in Paragraph "Decontamination Procedures."
22. Establishing a Mini-Containment area:
  - a. Establish work area so that unauthorized entry is prevented; Construct a two-compartment fire treated wood frame around work area; install one layer 6-mil polyethylene sheeting to structural members and two layers 6 mil polyethylene sheeting to the floor. Exception: no floor required if mini-containment is being constructed to perform a floor tile activity. Seal all edges to wall, ceiling, and floor surfaces with duct tape. Install viewing inspection windows, where feasible.
  - b. Seal all penetrations with duct tape such as pipes, electrical conduit, or ducts contained within the mini-containment.
  - c. Install triple 6-mil polyethylene flaps at both doorways. Place portable sprayer with clean water, disposable towels, and pre-labeled disposal bag in air lock.
  - d. Install appropriate signs on outside of mini-containment area.
  - e. Install HEPA vacuum; extend hose into mini-containment area for general vacuuming, negative air, and cleaning of disposal suit.
  - f. Accumulate all loose materials for disposal. Place in approved container. Apply appropriate labels. Adequately wet clean all wall, floor, tool and equipment surfaces.
  - g. Abatement worker must wear two disposable suits. Remove outer suit in work area and place in a plastic bag. Enter air lock.
  - h. In air lock, wet wipe respirator and wash hands with clean water. Remove respirator and place in a clean plastic bag. Proceed to remote shower unit where inner suit may be removed.

#### E. Worker Protection

1. This section describes the equipment and procedures required for protecting workers against asbestos contamination and other work place hazards except for respiratory protection.
2. Respiratory Protection is specified in Paragraph "Respiratory Protection."



3. Train in accordance with EPA's Model Accreditation Plan, 40 CFR 763 - Asbestos, all workers in the dangers inherent in handling asbestos and breathing asbestos dust and in proper work procedures and personal and area protective measures. Include but do not limit the topics covered in the course to the following:
  - a. Methods of recognizing asbestos.
  - b. Health effects associated with asbestos.
  - c. Relationship between smoking and asbestos in producing lung cancer.
  - d. Nature of operations that could result in exposure to asbestos.
4. Importance of and instruction in the use of necessary protective controls, practices and procedures to minimize exposure including:

Engineering controls  
Work practices  
Respirators  
Housekeeping procedures  
Hygiene facilities  
Protective clothing  
Decontamination procedures  
Emergency procedures  
Waste disposal procedures  
Appropriate work practices for the work  
Requirements of medical surveillance program  
Review of OSHA 29 CFR 1926.1101(k)(9)(viii)(G) - Asbestos  
Pressure differential systems  
Work practices including hands on or on job training  
Personal decontamination procedures  
Air monitoring, personal and area

5. Provide medical examinations for all workers who may encounter an airborne fiber level of 0.1 f/cc or greater for an 8 hour time weighted average. In the absence of specific airborne fiber data, provide medical examination for all workers who will enter the work area for any reason. Examination shall, at minimum, meet OSHA requirements as set forth in 29 CFR 1926.1101(k)(9)(viii)(G) - Asbestos. In addition, provide an evaluation of the individual's ability to work in environments capable of producing heat stress in the worker.
6. Before start of work Contractor shall submit the following to the Owner's Representative for review. Do not start work until receipt of the Owner's Representative.
  - a. An original signed copy of the Certificate of Worker's Acknowledgement found at the end of this specification, for each worker who is to be at the job site or enter the work area.
  - b. Courses outline or name of institution providing the worker training course.
  - c. Report from medical examination conducted within last 12 months as part of compliance with OSHA medical surveillance requirements for each worker who is to enter the work area.
7. Provide disposable full-body coveralls and disposable head covers, and require that they be worn by all workers in the work area. Provide a sufficient number for all required changes, for all workers in the work area.
8. Provide work boots with non-skid soles, and where required by OSHA, foot protectives, for all workers. Provide boots at no cost to workers. Paint uppers of all boots red with water proof enamel. Do not allow boots to be removed from the work area for any reason, after being contaminated with asbestos-containing material. Dispose of boots as asbestos contaminated waste at the end of the work.
9. Provide head protectives (hard hats) as required by OSHA for all workers, and provide four spares for use by the Owner's Representative, and the Owner. Label hats with same warning labels as used on disposal bags. Require hard hats to be worn at all times that work is in progress that may potentially cause head injury. Provide hard hats with plastic strap type suspension. Require hats



to remain in the work area throughout the work. Thoroughly clean, decontaminate and bag hats before removing them from work area at the end of the work.

10. Provide eye protectives (goggles) as required by OSHA for all workers involved in scraping, spraying, or any other activity which may potentially cause eye injury.
11. Provide work gloves to all workers and require that they be worn at all times in the work area. Do not remove gloves from work area. Dispose of gloves as asbestos contaminated waste at the end of the work.
12. Respirators, disposable coveralls, head covers, and footwear covers shall be provided by the contractor for the Owner, the Owner's Representative, and other authorized representatives who may inspect the job site.
13. Provide worker protection as required by the most stringent OSHA and/or EPA standards applicable to the work. The following procedures are minimums to be adhered to regardless of fiber count in the work area.
14. Each time work is entered, remove all street clothes in the changing room of the Personnel Decontamination Unit and put on new disposable coverall, new head cover, and a clean respirator. Proceed through shower room to equipment room and put on work boots.
15. In the event a mini-enclosure is used refer to Paragraph "Work Area Preparation" for personal decontamination procedures.

#### F. Respiratory Protection

1. Instruct and train each worker involved in asbestos abatement or maintenance and repair of friable asbestos-containing materials in proper respiratory use and require that each worker always wear a respirator, properly fitted on the face in the work area from the start of any operation which may cause airborne asbestos fibers until the work area is completely decontaminated. Use respiratory protection appropriate for the fiber level encountered in the work place or as required for other toxic or oxygen-deficient situations encountered.
2. Except to the extent that more stringent requirements are written directly into the Contract Documents, the following regulations and standards have the same force and effect (and are made a part of the Contract Documents by reference) as if copied directly into the Contract Documents, or as if published copies were bound herewith. Where there is a conflict in requirements set forth in these regulations and standards meet the more stringent requirement.
  - a. OSHA - U.S. Department of Labor Occupational Safety and Health Administration, Safety and Health Standards 29 CFR 1910, Section 1001 and Section 1910.134.29 CFR 1926.
  - b. ANSI - American National Standard Practices for Respiratory Protection. ANSI Z88.2-1980.
  - c. NIOSH - National Institute for Occupational Safety and Health.
  - d. MSHA - Mine Safety and Health Administration.

#### G. Type Of Respiratory Protection Required

1. Provide Respiratory Protection as indicated in paragraph below. Where paragraph below does not apply, determine the proper level of protection by dividing the expected or actual airborne fiber count in the work area by the "protection factors" given below. The level of respiratory protection which supplies an airborne fiber level inside the respirator, at the breathing zone of the wearer, at or below 0.01 fibers/cubic centimeter is the minimum level of protection allowed.
2. Eight-hour Time Weighted Average (TWA) of asbestos fibers to which any worker may be exposed shall not exceed 0.1 fibers/cubic centimeter.
3. For purposes of this section fibers are defined as all fibers regardless of composition as counted in the OSHA Reference Method (ORM), NIOSH P&CAM 239 or 7400 procedure, or asbestos fibers of any size as counted using either a scanning or transmission electron microscope.
4. Require that respiratory protection be used at all times that there is any possibility of disturbance of asbestos-containing materials whether intentional or accidental.
5. Require that a respirator be worn by anyone in a work area at all times, regardless of activity, during a period that starts with any operation which could cause airborne fibers until the area has been cleared for re-occupancy.



## H. Respiratory Protection Factor

<u>Respirator Type</u>	<u>Protection Factor</u>
Air purifying: Negative pressure respirator High efficiency filter Half facepiece	10
Air purifying: Negative pressure respirator High efficiency filter Full facepiece	50
Powered-air purifying (PAPR): Positive pressure respirator High efficiency filter Half or Full facepiece	100
Type C supplied air: Positive pressure respirator continuous-flow Half or full facepiece	100
Type C supplied air: Positive pressure respirator pressure demand Full facepiece	1000
Type C supplied air: Positive pressure respirator pressure demand Full facepiece Equipped with an auxiliary positive pressure Self-contained breathing apparatus (SCBA)	over 1000
Self-contained breathing apparatus (SCBA): Positive Pressure respirator Pressure demand Full facepiece	over 1000

## I. Air Purifying Respirator

1. Provide half face or full face type respirators. Equip full-face respirators with a nose cup or other anti-fogging device as would be appropriate for use in air temperatures less than 32 degrees Fahrenheit.
2. Provide, at a minimum, HEPA type filters labeled with NIOSH and MSHA certification for "Radionuclides, Radon Daughters, Dust, Fumes, Mists including Asbestos-Containing Dusts and Mists" and color coded in accordance with ANSI Z228.2 (1980). In addition, a chemical cartridge section may be added, if required, for solvents, etc., in use. In this case, provide cartridges that have each section of the combination canister labeled with the appropriate color code and NIOSH/MSHA Certification.
3. Supply with a sufficient quantity of respirator filters approved for asbestos, so that workers can change filters during the work day. Require that respirators be wet-rinsed, and filters discarded, each time a worker leaves the work area. Require that new filters be installed each time a worker re-enters the work area. Store respirators and filters at the job site in the changing room and protect totally from exposure to asbestos prior to their use. Do not use single use, disposable or quarterface respirators.



- J. Powered Air Purifying Respirator (PAPR)
1. Provide full-facepiece type respirators. Provide nose-cups for full-facepiece respirators. Provide, at a minimum, HEPA type cartridges approved by NIOSH/MSHA and certified for use in atmospheres containing asbestos dusts.
  2. Provide, at a minimum, one extra battery pack for each respirator so that one can be charging while one is in use.
  3. Provide non-cloth belts capable of being decontaminated in shower.
  4. Supply with a sufficient quantity of high efficiency respirator filters approved for asbestos so that workers can change filters at any time that flow through the face piece decreases to the level at which the manufacturer recommends filter replacement. Require that regardless of flow, filter cartridges be replaced after 40 hours of use. Require that HEPA elements in filter cartridges be protected from wetting during showering. Require entire exterior housing of respirator including blower unit, filter cartridges, hoses, battery pack, face mask, belt, and cords to be washed each time a worker leaves the work area. Caution should be used to avoid shorting battery pack during washing.
- K. Required Respiratory Protection
1. Regardless of airborne fiber levels, require the following minimum level of respiratory protection:
    - a. Half-face air purifying respirators may be used during set-up of the containment and removal of the material so long as fiber counts inside the respirator do not exceed .01 f/cc fibers per cubic centimeter.
- L. Decontamination Units -Three-Stage
1. Provide a Personnel Decontamination Unit consisting of a serial arrangement of rooms or spaces, Changing Room, Shower Room, Equipment Room adjacent to each full containment area.
  2. Require all persons without exception to pass through this decontamination unit for entry into and exiting from the work area for any purpose. Do not remove equipment or materials through Personnel Decontamination Unit.
  3. Changing (Clean) Room:
    - a. Provide a room that is physically and visually separated from the rest of the building for the purpose of changing into protective clothing.
    - b. Locate so that access to work area from changing room is through shower room.
    - c. Separate changing room from the building by a double-sheeted polyethylene flapped doorway.
    - d. Provide sub-panel at changing room to accommodate all removal equipment. Power sub-panel directly from a building electrical panel. Connect all electrical branch circuits in decontamination unit and particularly any pumps in shower room to a ground-fault circuit protection device.
  4. Shower Room:
    - a. Provide a completely water tight operational shower to be used for transit by cleanly dressed workers heading for the work area from the changing room, or for showering by workers headed out of the work area after undressing in the equipment room.
    - b. Construct room by providing a shower pan and two shower walls in a configuration that will cause water running down walls to drip into pan. Install a freely draining wood floor in shower pan at elevation of top of pan.
    - c. Separate this room from rest of building, drying room and airlock with airtight walls fabricated of 6-mil polyethylene.
    - d. Provide splash proof entrances to Drying Room and Airlock.
  5. Equipment Room (contaminated area):
    - a. Require work equipment, footwear and additional contaminated work clothing to be left here. This is a change and transit area for workers. Separate this room from the work area by a 6-mil polyethylene flap doorway.
    - b. Separate this room from the rest of the building, the shower room and work area with air tight walls fabricated of 6-mil polyethylene.



- 6. Clean Room: Provide Clean Room to isolate the holding room from the building exterior.
- 7. Load-out Area:
  - a. The load-out area is the transfer area from the building to a truck or dumpster.
  - b. Wet wipe bags before they are passed through the equipment decon-chamber.
  - c. When cleaning is complete pass items into holding room. Close all doorways except the doorway between the holding room and the Clean Room.
  - d. Workers from the area outside the containment area enter holding area and remove decontaminated equipment and/or containers for disposal.
  - e. Require these workers to wear full protective clothing and appropriate respiratory protection.
  - f. At no time is a worker from an uncontaminated area to enter the enclosure when a removal worker is inside.
  - g. Post an approximately 20 inch x 14 inch manufactured caution sign at each entrance to the work area displaying the following legend with letter sizes and styles of a visibility required by OSHA 29 CFR 1926.1101(k)(9)(viii)(J) - Asbestos.

LEGEND  
DANGER

ASBESTOS

**CANCER AND LUNG DISEASE HAZARD**  
RESPIRATORS AND PROTECTIVE CLOTHING ARE REQUIRED  
IN THIS AREA

- h. Provide spacing between respective lines at least equal to the height of the respective upper line.
- i. Additional Signage: Shall also be posted in accordance with OSHA 29 CFR 1926.1101(k)(9)(viii)(J) - Asbestos

DANGER  
ASBESTOS  
CANCER AND LUNG DISEASE HAZARD

**AUTHORIZED PERSONNEL ONLY**  
RESPIRATORS AND PROTECTIVE CLOTHING  
ARE REQUIRED IN THIS AREA

DANGER  
ASBESTOS  
CANCER AND LUNG HAZARD  
KEEP OUT

- j. Post an approximately 10 inch by 14 inch manufactured sign at each entrance to each work area displaying the following legend with letter sizes and styles of a visibility at least equal to the following:

<u>LEGEND</u>	<u>NOTATION</u>
No Food, Beverages or Tobacco Permitted	3/4 inch Block
All Persons Shall Don Protective Clothing (Coverings) Before Entering the Work Area	3/4 inch Block
All Persons Shall Shower Immediately After Leaving Work Area and Before Entering the Changing Area	3/4 inch Block



#### M. Decontamination Procedures

1. Contractor shall require all workers and visitors to adhere to the following personal decontamination procedures whenever they leave the work area:
  - a. Require that all workers use the following decontamination procedure as a minimum requirement whenever leaving the work area.
  - b. When exiting area, remove disposable coveralls, disposable head covers, and disposable footwear covers or boots in the Equipment Room.
  - c. Still wearing respirators, proceed to showers. Showering is mandatory. Care must be taken to follow reasonable procedures in removing the respirator to avoid asbestos fibers while showering. The following procedure is required as a minimum:
    - 1) Thoroughly wet body including hair and face. If using a PAPR, hold blower unit above head to keep canisters dry.
    - 2) With respirator still in place thoroughly wash body, hair, respirator face piece, and all parts of the respirator except the blower unit and battery pack on a PAPR. Pay particular attention to seal between face and respirator and under straps.
    - 3) Take a deep breath, hold it and/or exhale slowly, completely wet hair, face, and respirator. While still holding breath, remove respirator and hold it away from face before starting to breathe.
    - 4) Carefully wash face-piece of respirator inside and out.
  - d. If using PAPR, shut down in the following sequence, first cap inlets to filter cartridges, then turn off blower unit (this sequence will help keep debris which has collected on the inlet side of filter from dislodging and contaminating the outside of the unit). Thoroughly wash blower unit and hoses. Carefully wash battery pack with wet rag. Be extremely cautious of getting water in battery pack as this will short out and destroy battery.
    - 1) Shower completely with soap and water.
    - 2) Rinse thoroughly.
    - 3) Rinse shower room walls and floor prior to exit.
    - 4) Proceed from shower to changing room and change into street clothes or into new disposable work items.
  - e. Require that all workers use the following decontamination procedure as a minimum requirement whenever leaving the work area with a half or full face cartridge type respirator:
    - 1) When exiting area, remove disposable coveralls, disposable headcovers, and disposable footwear covers or boots in the equipment room.
    - 2) Still wearing respirators, proceed to showers. Showering is mandatory. Care must be taken to follow reasonable procedures in removing the respirator and filters to avoid asbestos fibers while showering. The following procedure is required as a minimum:
      - 3) Thoroughly wet body from neck down.
      - 4) Wet hair as thoroughly as possible without wetting the respirator filter if using an air purifying type respirator.
      - 5) Take a deep breath, hold it and/or exhale slowly, complete wetting of hair, thoroughly wetting face, respirator and filter (air purifying respirator). While still holding breath, remove respirator and hold it away from face before starting to breath.
      - 6) Dispose of wet filters from air purifying respirator.
      - 7) Carefully wash facepiece of respirator inside and out.
      - 8) Shower completely with soap and water.
      - 9) Rinse thoroughly.
      - 10) Rinse shower room walls and floor prior to exit.
      - 11) Proceed from shower to changing room and change into street clothes or into new disposable work items.

#### N. Project Decontamination

1. If the asbestos abatement work is on damaged or friable materials, then the building space is deemed contaminated before start of the work and in need of decontamination. In this case, the



- procedure includes two cleanings of the primary barrier plastic prior to its removal and two cleanings of the room surfaces to remove any new or existing contamination.
2. Work of this section includes the decontamination of air in the work area which has been, or may have been contaminated by the elevated airborne asbestos fiber levels generated during abatement activities, or which may previously have had elevated fiber levels due to friable materials in the space.
  3. Work of this section also includes the cleaning, decontamination, and removal of temporary facilities installed prior to abatement work and decontamination of all surfaces (ceiling, walls, floor) of the work area, and all furniture or equipment in the work area.
  4. First Cleaning
    - a. Carry out a first cleaning of all surfaces of the work area including items of remaining sheeting, tools, scaffolding and/or staging by use of damp-cleaning and mopping, and/or a HEPA filtered vacuum. (Note: A HEPA vacuum will fail if used with wet material). Do not perform dry dusting or dry sweeping. Use each surface of a cleaning cloth one time only and then dispose as contaminated waste. Continue this cleaning until there is no visible debris from removed materials on plastic sheeting or other surfaces. Upon authorization of the Owner's Representative proceed with encapsulation of substrate.
    - b. Perform encapsulation of substrate where required at this time. Maintain pressure differential system in operation during encapsulation work. Allow encapsulant to dry before proceeding with removal of Secondary layer of plastic.
  5. Second Cleaning
    - a. Upon authorization of the Owner's Representative, remove all Primary Barrier sheeting and Material Decontamination Unit, if there is one, leaving only the following:
      - 1) Critical Barrier which forms the sole barrier between the work area and other portions of the building or outside.
      - 2) Critical Barrier Sheeting over lighting fixtures and clocks, ventilation openings, doorways, convectors, speakers and other openings.
      - 3) Personnel Decontamination Unit.
      - 4) Pressure Differential System in continuous operation.
    - b. Remove all filters in Air Handling System(s) and dispose of as asbestos-containing waste.
  6. Final Cleaning: Carry out a final cleaning of all surfaces in the work in the same manner as the first cleaning immediately after removal of primary plastic. This cleaning is now being applied to existing room surfaces. Take care to avoid water marks or other damage to surfaces.
  7. Visual Inspection: Perform a complete visual inspection with the Owner's Representative of the entire work area including decontamination unit, all plastic sheeting, seals over ventilation openings, doorways, windows, and other openings; look for debris from any sources, residue on surfaces, dust or other matter. If any such debris, residue, dust or other matter is found repeat cleaning and continue decontamination procedure from that point. When the area is visually clean, complete the certification at the end of this section.
  8. Final Air Sampling
    - a. After the work area is found to be visually clean, air samples will be taken and analyzed in accordance with the procedures set forth in Paragraph "Powered Air Purifying Respirator (PAPR).
    - b. If Release Criteria are not met, repeat cleaning and continue decontamination procedure from that point.
    - c. If Release Criteria is met, remove the interior of the decontamination unit leaving in place only the Critical Barriers separating the work area from the rest of the building and the operating negative pressure system.
    - d. Any small quantities of residual material found upon removal of the plastic sheeting shall be removed with a HEPA filtered vacuum cleaner and local area protection. If significant quantities, as determined by the Owner's Representative, are found then the entire area affected shall be decontaminated as specified herein for the cleaning.

- O. Work Area Clearance  
1. Air Monitoring



- a. Visual Inspection is required as a prerequisite of air testing.
- b. To determine if the elevated airborne asbestos structure concentration during abatement operations have been reduced to the specified level, the Owner's Representative will secure samples and analyze them according to the following procedures.
- 2. Aggressive Sampling
  - a. All air samples will be taken using aggressive sampling techniques as follows. (There are no standards available for flow rate of leaf blowers or large fans. However, this information is not critical to the success of the procedure).
  - b. Before sampling pumps are started, the exhaust from forced-air equipment (leaf blower with at least 1 horsepower electric motor) will be swept against all walls, ceilings, floors, ledges and other surfaces in the room. This procedure will be continued for five minutes per 10,000 cubic feet of room volume.
  - c. Air samples will be collected in areas subject to normal air circulation away from room corners, obstructed locations, and sites near windows, doors or vents.
- 3. Schedule of Air Samples
  - a. General: The number and volume of air samples taken and analytical methods used by the Owner's Representative will be in accordance with the following schedule. Sample volumes given may vary depending upon the analytical instruments used. In each homogeneous work area after completion of all cleaning work, samples will be taken and analyzed by either PCM or TEM analysis.
  - b. Transmission Electron Microscopy (TEM) Samples:
    - 1) In each homogeneous work area after completion of all cleaning work, samples will be taken and analyzed by either PCM or TEM analysis as follows:
    - 2) Samples will be collected on 25 mm cassettes with filter media: TEM - 0.45 micrometer mixed cellulose ester or 0.40 micrometer polycarbonate, with 5.0 micron mixed cellulose ester backing filter.

Location Sampled	Number of Samples	Detection Limit (f/cc)	Minimum Volume (Liters)	Rate LPM
Each Work Area	5	0.005	1,300	2-10

- 3) TEM Analysis will be performed using the analysis method set forth in the AHERA Regulation 40 CFR Part 763 Appendix A.
- 4) Asbestos Structures referred to in this Section include asbestos fibers, bundles, clusters, or matrices, as defined by method of analysis.
- 5) Decontamination of the work site is complete when all the sample results are below 0.01 fibers per cubic centimeters (f/cc) of air or 70 structures per square millimeter.
- c. Phase Contrast Microscopy (PCM) Samples:
  - 1) In each homogeneous work area after completion of all cleaning work, samples may be taken and analyzed as follows:
  - 2) Samples will be analyzed by PCM for clearance in areas where ceiling tile and/or pipe insulation are removed
  - 3) Samples will be collected on 25 mm cassettes with filter media: PCM - 0.8 micrometer mixed cellulose ester.

Location Sampled	Number of Samples	Detection Limit (s/cc)	Minimum Volume (Liters)	Rate LPM
Each Work Area	1-5	0.01	2,400	2-10

- 4) PCM Analysis: Fibers on each filter will be measured using the NIOSH 7400 Method entitled "Fibers" published in the NIOSH Manual of Analytical Methods, 3rd Edition, Second Supplement, August 1987.



- 5) Fibers: Referred to in this section include fibers regardless of composition as counted by the phase contrast microscopy method used
  - 6) Decontamination of the work site is complete when all the sample results are below 0.01 fibers per cubic centimeters (f/cc) of air or 70 structures per square millimeter.
4. Failure of Clearance Sampling: Should results from analysis of final clearance air samples not meet the specified criteria, Contractor will be responsible for the payment of all costs, including Consultant's time for subsequent clearance air sampling. The costs associated with subsequent re-sampling for final clearance shall be deducted from the Contractor's final payment of the contract amount.

P. Removal Of Pipe Insulation

1. The work of this section applied to the removal of asbestos-containing Pipe Insulation.
  - a. Place one layer of 6-mil fire retardant polyethylene sheeting directly below the work. The sheet shall be of sufficient size to completely wrap the pipe once it has been removed.
  - b. Thoroughly wet the ends of the pipe with amended water and scrape off a minimum of 6 inches of asbestos wrap from both ends of the pipe. Immediately place the wetted material into pre-labeled asbestos disposal bag(s).
  - c. Detach the pipe at each scraped end and place the pipe onto one sheet of 6-mil fire retardant polyethylene sheeting. Wrap the pipe with the 6-mil fire retardant polyethylene sheeting. Contractor shall wrap the pipe with a second sheet of 6-mil, fire retardant polyethylene sheeting and label as asbestos-containing material. Dispose of the bag(s) and duct in accordance with the Paragraph "Handling and Disposal of Asbestos Contaminated Waste" of this specification.
  - d. Upon clearance from the Owner's Representative, Contractor shall remove the 6-trail, fire retardant polyethylene sheeting from the openings.

Q. Glove Bag Removal

1. The work of this section applies to full containment or glovebag removal.
2. Isolate the area in accordance with Paragraph "Temporary Facilities."
3. Construct a decontamination unit as described in Paragraph "Decontamination Units" and attach to the work area.
4. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph "Pressure Differential System."
  - a. Upon approval of the enclosure by the Owner's Representative, Contractor may proceed to remove the material using the following method.
  - b. Thoroughly wet to satisfaction of the Owner's Representative, asbestos-containing insulation to be removed prior to stripping and/or tooling to reduce fiber dispersal into the air. Accomplish wetting by a fine spray (mist) of amended water or removal encapsulant. Saturate material sufficiently to wet the substrate without causing excess dripping. Allow time for removal encapsulant to penetrate material thoroughly. If amended water is used, spray material repeatedly during the work process to maintain a continuously wet condition. If a removal encapsulant is used, apply in strict accordance with manufacturer's written instructions. If insulation is covered with canvas, Contractor will wet the exterior covering and slice it with utility knife while saturating the material.
  - c. Mist work area continuously with amended water whenever necessary to reduce airborne fiber levels using commercially available "foggers."
  - d. Remove saturated asbestos-containing material in small sections from all areas. Do not allow material to dry out. As it is removed, simultaneously pack material while still wet into disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside and move to wash down station adjacent to material decontamination unit.
  - e. Evacuate air from disposal bags with a HEPA filtered vacuum cleaner before sealing.
  - f. Contractor must always clean area of visible asbestos debris prior to end of shift.
5. These procedures shall be followed to remove pipe insulation elbows:
  - a. Install critical barriers to isolate the work site. Install 2 or 3 Stage Decontamination Units.



- b. HEPA vacuum the work site.
  - c. Provide negative air machine in addition to those required, in the vicinity of the work. Arrange so that exhaust is into the work area, oriented in a direction away from the work. Extend a 2-inch diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.
  - d. Locate intake of duct so that airflow is horizontally and slightly downward into intake. Replace primary filter on negative air machine at an interval of no greater than 30 minutes. Allow no more than one scraping or brushing activity per negative air machine.
  - e. Check pipe where the work will be performed. Wrap damaged (broken lagging, hanging, etc.), pipe in 6 mil plastic and "candy-stripe" with duct tape. Place one layer of duct tape around undamaged pipe at each end where the glovebag will be attached.
  - f. Place necessary tools into pouch located inside glovebag. This will usually include: bone saw, utility knife, rags, scrub brush, wire cutters, tin snips and pre-wetted cloth.
  - g. Place one strip of plastic adhesion tape along the edge of the open top slit of glove bag for reinforcement.
  - h. Place the glove bag around section of pipe to be worked on and staple top together through reinforcing tape. Next, tape the ends of glovebag to pipe itself, where previously covered with plastic or tape.
  - i. Use smoke tube and aspirator bulb to test seal. Place tube into water sleeve (two-inch opening to glovebag) squeezing bulb and filling bag with visible smoke. Remove smoke tube and twist water sleeve closed. While holding the water sleeve tightly, gently squeeze glovebag and by using a flashlight, look for smoke leaking out, (especially at the top and ends of the glovebag). If leaks are found, tape closed using plastic adhesion tape and re-test.
  - j. Insert wand from garden sprayer through water sleeve. Plastic adhesion tape water sleeve tightly around the wand to prevent leakage.
  - k. One person places its hands into the long-sleeved gloves while the second person directs garden sprayer at the work.
  - l. Use bone saw, if required, to cut insulation at each end of the section to be removed. A bone saw is a serrated heavy gauge wire with ring-type handles at each end. Throughout this process, spray amended water or removal encapsulant on the cutting area to keep dust to a minimum.
  - m. Remove insulation using putty knives or other tools. Place pieces in bottom of bag without dropping.
  - n. Rinse all tools with water inside the bag and place back into pouch.
  - o. Using scrub brush, rags and water, scrub and wipe down the exposed pipe. (Inexpensive horse rub-down mittens work well for this).
  - p. Remove water wand from water sleeve and attach the small nozzle from HEPA-filtered vacuum. Turn on the vacuum only briefly to collapse the bag.
  - q. Remove the vacuum nozzle, twist water sleeve closed and seal with plastic adhesion tape.
- R. Handling And Disposal Of Asbestos-Containing Waste
- 1. All waste and asbestos contaminated waste shall be double bagged in pre-labeled 6-mil airtight puncture resistant bags. Labeling shall be in accordance with OSHA and EPA requirements.
    - a. Bags of asbestos-containing waste shall be sealed with tape in the work area. Asbestos waste shall not be allowed to dry out prior to sealing bags. While in the work area, bags shall be decontaminated of any bulk debris by wet wiping. Bags shall be pre-labeled in accordance with OSHA and EPA.
    - b. The Contractor shall ensure that the sealed bags are transported to the waste disposal site.
  - 2. The Contractor shall establish a manifest system to enable the Owner to report the quantity of asbestos waste being deposited at the landfill. Contractor shall report the quantity of waste in pounds or tons as appropriate. The Contractor must be able to demonstrate custody over all asbestos waste from the time it is removed from the work area until it is deposited at the land fill.



- a. Copies of the manifest and any receipts generated during the handling and disposal process shall be provided to the Owner's Representative and the Owner.
  - b. Final manifest and documents must be provided to the Owner's Representative and the Owner within two weeks of the removal of the asbestos materials from the site by the waste hauler.
- S. Encapsulation Of Asbestos-Containing Materials
1. General provisions of Contract, including General and Supplementary Conditions and Division 01, apply to work of this section.
    - a. The work includes the sealing of all piping or vessels from which asbestos-containing insulation has been removed with one coat of a lock down encapsulant.
    - b. Where repair work is being performed, the end will be sealed with a minimum of one coat of bridging encapsulant.
  2. Submittals
    - a. Product Data: Submit manufacturer's technical information including label analysis and application instructions for each material proposed for use.
    - b. Installation Instructions: Submit manufacturer's installation instructions with specific project requirements noted.
    - c. Performance Warranty: Submit manufacturer's performance guarantee.
    - d. Certification: Submit written approval of entity installing the encapsulant from encapsulant manufacturer.
    - e. Material Safety Data Sheet: Submit the Material Safety Data Sheet, or equivalent, in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200) for each surfactant and encapsulating material proposed for use on the work. Include a separate attachment for each sheet indicating the specific worker protective equipment proposed for use with the material indicated.
  3. Deliver materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
    - a. Name or title of material
    - b. Manufacturer's stock number and date of manufacture
    - c. Manufacturer's name
    - d. Thinning Instructions
    - e. Application Instructions
  4. Deliver materials together with a copy of the OSHA Material Safety Data Sheet for the material.
  5. Job Conditions
    - a. Apply encapsulating materials only when environmental conditions in the work area are as required by the manufacturer's instructions.
  6. Quality Assurance
    - a. Installation of Spray-on Encapsulation Materials: Install spray-on materials by a firm and personnel approved by the manufacturer of the primary materials.
    - b. Testing: Test material to be encapsulated using methods set forth in ASTM E1494 "Standard Practice for Encapsulants Spray-or-Trowel-Applied for Friable Asbestos-Containing Building Materials."
    - c. Performance Warranty: Submit written Performance Warranty, executed by the manufacturer and co-signed by the Contractor, agreeing to repair/replace spray-on work which has cracked, fallen from substrate, or otherwise deteriorated to a condition where it would not perform effectively for its intended purposes due substantially to defective materials or workmanship and not due to abuse by occupants, improper maintenance, non-foreseeable ambient exposures or other causes beyond anticipated conditions and manufacturer's/contractor's control.
    - d. Compatibility: Selection and use of encapsulant shall be compatible with replacement materials. Submit manufacturer's data indicating compatibility with replacement materials.
  7. Product Selection
    - a. Encapsulants: Provide penetrating or bridging type encapsulants specifically designed for application to asbestos-containing material.



- b. Standards: Product shall be rated as acceptable for use intended when field tested in accordance with ASTM E1494 "Standard Practice for Encapsulants Spray-or-Trowel-Applied for Friable Asbestos-Containing Building Materials."
  - c. Fire Safety: Use only materials that have a flame spread index of less than 25, when dry, when tested in accordance with ASTM E84.
8. Manufacturers
- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products, which may be incorporated in the work, include, but are not limited to the following:
    - 1) Penetrating Encapsulants: As currently accepted by the EPA. Refer to most recent EPA approval list.
    - 2) Bridging Encapsulants: As currently accepted by the EPA. Refer to most recent EPA approval list.
9. General
- a. Prior to applying any encapsulating material, ensure that application of the sealer will not cause the base material to fail and allow the sealed material to fall of its own weight or separate from the substrate. Should Contractor doubt the ability of the installation to support the sealant, request direction from the Owner's Representative before proceeding with the encapsulating work.
  - b. Do Not Commence Application of encapsulating materials until all removal work within the work area has been completed.
10. Worker Protection
- a. Before beginning work with any material for which a Material Safety Data Sheet has been submitted, provide workers with the required protective equipment. Require that appropriate protective equipment be used at all times.
  - b. In addition to protective breathing equipment required by OSHA requirements or by this specification, use painting pre-filters on respirators to protect the dust filters when organic solvent based encapsulants are used.
11. Substrate
- a. Apply lock down encapsulant to all substrate after all asbestos-containing materials have been removed. Apply in strict accordance with the manufacturer's printed instructions for use of the encapsulation as an asbestos coating. Any deviations from such printed instructions shall be approved by the Owner's Representative in writing prior to commencing work.
  - b. Apply encapsulant with an airless spray gun with air pressure and nozzle orifice as recommended by the encapsulant manufacturer.
- T. Removal Of Floor Tile
- 1. This section applies to the removal of floor tile.
    - a. Prior to start of work, wet wipe all surfaces including floor tile to remove any visible dust.
    - b. Isolate the room by sealing hallway or doors and installing critical barriers on all ducting, windows and other penetrations of the room, in the specified area. Install a splash guard a minimum of 4 feet high on the walls of the room with one layer of 6-mil fire retardant poly.
    - c. Install a two-stage decontamination configuration contiguous (under certain conditions may be remote) with the work in accordance with Paragraph "Decontamination Units."
    - d. Using water or amended water in a Hudson-type sprayer or garden sprayer, lightly mist the area where the material is to be removed. This may take several passes with the hose of the sprayer. Allow time for the water to soak into the material.
    - e. Immediately place individual tiles in proper asbestos disposal bags. Vacuum collapse the bag, twist the neck of the bag, tape with duct tape, fold the twisted portion over onto itself and tape again. Wipe the outside of the bag with clean damp cloths and place the bag into a second prelabeled disposal bag. Tape shut the second bag.
- U. Removal Of Fireproofing



1. The work of this section applies to the removal of all asbestos containing fireproofing including all over-spray that may be located on concrete block, columns, metal deck, beams, fixtures conduit and ducting.
  - a. Isolate the floor per Paragraph "Temporary Enclosure."
  - b. Construct a decontamination unit as described in Paragraph "Decontamination Units" and attach to the work area.
  - c. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph "Temporary Pressure Differential and Air Circulation System."
  - d. Upon approval of the enclosure by the Owner's Representative, contractor may proceed to remove the material using the following method.
  - e. Pre-clean columns, beams, electrical, mechanical and plumbing systems in the work area using wet wipe and HEPA vacuuming methods. Mask off with flame retardant polyethylene sheeting to protect from contamination during bulk abatement.
  - f. Thoroughly wet to satisfaction of the Owner's Representative, asbestos-containing fireproofing to be removed prior to stripping and/or tooling to reduce fiber dispersal into the air. Accomplish wetting by a fine spray (mist) of amended water or removal encapsulant. Saturate material sufficiently to wet the substrate without causing excess dripping. Allow time for removal encapsulant to penetrate material thoroughly. If amended water is used, spray material repeatedly during the work process to maintain a continuously wet condition. If a removal encapsulant is used, apply in strict accordance with manufacturer's written instructions.
  - g. Mist work area continuously with amended water whenever necessary to reduce airborne fiber levels using commercially available "foggers."
  - h. Remove saturated asbestos-containing material in small sections from all areas. Do not allow material to dry out. As it is removed, simultaneously pack material while still wet into disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside and move to wash down station adjacent to material decontamination unit.
  - i. Evacuate air from disposal bags with a HEPA filtered vacuum cleaner before sealing.
  - j. Provide Pressure Differential Machine in addition to those required in Paragraph "Pressure Differential System," in the vicinity of the work. Arrange so that exhaust is into the work area, oriented in a direction away from the work. Extend a 12" diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.
  - k. Locate intake of duct so that air flow is horizontally and slightly down-ward into intake. Replace primary filter on pressure differential machine at an interval of no greater that 30 minutes. Allow no more than one scraping or brushing activity per pressure differential machine.
- V. Removal Of Wall Plaster: HEPA vacuum work site.
  1. Place two layers of 6-mil flame retardant polyethylene sheeting on the floor adjacent to the wall to be demolished. Pull the wall down in manageable sections onto the polyethylene sheeting. Control dust and fiber release by misting the air and lightly wetting the material with amended water from a Hudson-type sprayer or garden sprayer as it is demolished.
  2. Wrap the first layer of polyethylene sheeting around the material and seal with duct tape. Wrap the second layer of polyethylene sheeting around the bundle and seal with duct tape.
  3. Label and dispose of the entire bundle.
  4. Provide Pressure Differential Machine in addition to those required in Paragraph "Pressure Differential System," in the vicinity of the work. Arrange so that exhaust is into the work area, oriented in a direction away from the work. Extend a 12-inch diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.
  5. Locate intake of duct so that air flow is horizontally and slightly down-ward into intake. Replace primary filter on negative air machine at an interval of no greater that 30 minutes.

W. Clean-Up Of Asbestos-Containing Debris On Ceiling Tile Or Solid Ceiling



1. This section applies to the decontamination of the entire plaster ceiling, removal of existing fiberglass on duct work and removal of all batt insulation covering the existing plaster ceiling.
    - a. Isolate the floor per Paragraph "Temporary Facilities."
    - b. Construct a decontamination unit as described in Paragraph "Decontamination Units" and attach to the work area. General Contractor will give direction regarding exact location of decontamination unit(s).
    - c. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph "Temporary Pressure Differential and Air Circulation System."
    - d. Upon approval of the enclosure by the Owner's Representative, contractor may proceed to remove the material using the following method:
  2. These procedures shall be followed to for clean up of asbestos-containing debris on existing plaster ceiling:
    - a. This work will be performed prior to the removal of fireproofing. The isolation of the work area is considered essential to the pre-cleaning activities for the total area. Isolate the area in accordance with Paragraph "Temporary Facilities."
    - b. Remove asbestos-containing debris and fiberglass batt and duct insulation and decontaminate the area using the following procedures:
      - 1) Remove all small debris with the HEPA vacuum.
      - 2) Gently mist all fiberglass insulation, remove from ducts and ceiling and place into pre-labeled hazardous disposal bags and dispose of in accordance with Paragraph "Disposal of Asbestos Containing Waste Material."
      - 3) Exposure of ducting will expose all fireproofing overspray, this material may be removed during the removal of fireproofing from decks and beams.
      - 4) Pick up all large visible debris on the ceiling or any horizontal surfaces and place in the bottom of a 6-mil polyethylene disposal bag conforming to the requirements of Paragraph "Disposal of Asbestos-Containing Waste." Place pieces in the bag without dropping and avoiding unnecessary disturbance and release of material.
      - 5) HEPA vacuum the entire plaster ceiling surface.
    - c. Upon completion of the decontamination of the area request a visual inspection of the ceiling and other horizontal surfaces. This area will be considered a portion of work area for the duration of the work and will be included in the final encapsulation of the area.
- X. Removal Of Adhesive: This section applies to the removal of all asbestos-containing floor tile and adhesive, sheet vinyl flooring, vinyl floor tile, and baseboard adhesive, etc.
1. Ensure that workers are equipped with proper respiratory protection. In addition to the HEPA cartridges, respirators must also be equipped with organic solvent cartridges.
  2. Provide HEPA filtered fan units in the vicinity of the work. Arrange so that units exhaust outside the building. Replace primary filters on HEPA filtered fan units at an interval of no greater than 30 minutes.
  3. Apply adhesive removal solvent as recommended by manufacturer after removal of floor tile has been completed.
  4. Provide tile adhesive (mastic) remover that meets the following criteria:
    - a. Flash Point: 122E or greater.
    - b. Special Precautions: No heavy smoke generated if ignited.
    - c. Health Effects: Limited to mild skin rash or eye irritation.
    - d. Respiratory Protection: MSHA - NIOSH approved Organic vapor cartridges in conjunction with standard HEPA filters.
    - e. Petroleum Distillates: None.
    - f. Odor: Pine, Citrus or none.

**Use of diesel fuel in the removal of tile and baseboard adhesive is strictly prohibited.**

5. Remove adhesive in small sections from all areas. Do not allow material to dry out. As adhesive is removed, simultaneously pack rags contaminated with adhesive material into disposal bags. Twist



neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside of bag and move to material decontamination unit.

6. Upon completion of adhesive removal, thoroughly clean bare substrate of all solvent residue.
7. Place adhesive residue in proper asbestos disposal bags. Vacuum collapse the bag, twist the neck of the bag, tape with duct tape, fold the twisted portion over onto itself and tape again. Wipe the outside of the bag with clean damp cloths and place bag into second pre-labeled disposal bag. Tape shut the second bag.



**CERTIFICATE OF WORKER'S ACKNOWLEDGEMENT**

PROJECT NAME: \_\_\_\_\_

PROJECT ADDRESS: \_\_\_\_\_

CONTRACTOR: \_\_\_\_\_

**WORKING WITH ASBESTOS CAN BE DANGEROUS. INHALING ASBESTOS FIBERS HAS BEEN LINKED WITH VARIOUS TYPES OF CANCER IF YOU SMOKE AND INHALE ASBESTOS FIBERS, THE CHANCE THAT YOU WILL DEVELOP LUNG CANCER IS GREATER THAN THAT OF THE NON-SMOKING PUBLIC.**

Your employer's contract with the Owner for the above project requires that: You be supplied with the proper respirator and be trained in its use. You be trained in safe work practices and in the use of the equipment found on the job. You receive a medical examination. These things are to have been done at no cost to you. By signing this certification you are assuring the Owner that your employer has met these obligations to you.

RESPIRATORY PROTECTION: I have been trained in the proper use of respirators, and informed of the type respirator to be used on the above referenced project. I have a copy of the written respiratory protection manual issued by my employers. I have been equipped at no cost with the respirator to be used on the above project.

TRAINING COURSE: I have been trained in the dangers inherent in handling asbestos and breathing asbestos dust and in proper work procedures and personal and area protective measures. The topics covered in the course included the following:

- Physical characteristics of asbestos
- Health hazards associated with asbestos
- Respiratory protection
- Use of protective equipment
- Pressure differential systems
- Work practices including hands-on or on-the-job training
- Personal decontamination procedures
- Air monitoring, personal and area

MEDICAL EXAMINATION: I have had a medical examination within the last 12 months which was paid for by my employer. This examination included: health history, pulmonary function tests and may have included an evaluation of a chest x-ray.

Signature \_\_\_\_\_ Witness \_\_\_\_\_

Printed Name \_\_\_\_\_ Social Security Number \_\_\_\_\_



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**CERTIFICATION OF VISUAL INSPECTION**

**AREA** \_\_\_\_\_

In accordance with Paragraph "Project Decontamination" the Contractor hereby certifies that it has visually inspected the work area (all surfaces including pipes, beams, ledges, walls, ceiling and floor, Decontamination Unit, sheet plastic, etc.) and has found no dust, debris or residue.

By: \_\_\_\_\_

Signature \_\_\_\_\_ Date \_\_\_\_\_

Print Name \_\_\_\_\_

Print Title \_\_\_\_\_

OWNER'S REPRESENTATIVE CERTIFICATION

the Owner's Representative hereby certifies that it has accompanied the Contractor on its visual inspection and verifies that this inspection has been thorough and to the best of its knowledge and belief, the Contractor's certification above is a true and honest one.

Signature \_\_\_\_\_ Date \_\_\_\_\_

Print Name \_\_\_\_\_

Print Title \_\_\_\_\_



**RESPIRATORY PROTECTION PROGRAM**

Project Name \_\_\_\_\_

Location \_\_\_\_\_

Date \_\_\_\_\_

Based upon airborne asbestos-fiber counts encountered on previous projects of similar type working on materials similar to those found on the above referenced project. The following level of respiratory protection is proposed for the indicated operations to maintain an Airborne Fiber Count (as measured by the NIOSH 7400 Method) below the specified Permissible Exposure Limit (PEL) inside the respirator face piece.

Operation	Anticipated f/cc	Respiratory Protection	Protection Factor	f/cc in Mask
Installing sheet plastic				
Removing trim in contact with asbestos-containing material				
Removal of architectural finish or fireproofing				
Removal of pipe insulation				
Removal of fitting insulation				
Encapsulation of pipe and boiler insulation				
Gross debris removal				
Cleaning "primary" sheet plastic				
Cleaning "critical" barrier				
Removing Decontamination Unit				
Other				

The Contractor certifies that to the best of its knowledge and belief the above represent a true and accurate representation of Airborne Fiber Counts to be expected for the operations indicated, and are based upon airborne fiber data from past projects with similar materials and operations.

Contractor \_\_\_\_\_

Signature \_\_\_\_\_ Date \_\_\_\_\_

Print Name \_\_\_\_\_ Title \_\_\_\_\_

END OF SECTION 02 82 33 00



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**SECTION 02 82 33 00a - REMOVAL OF NONFRIABLE ASBESTOS-CONTAINING MATERIALS****1.1 GENERAL****A. Description Of Work**

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

**B. Definitions**

1. ACM: Asbestos Containing material which is any material containing more than one percent asbestos.
2. Amended Water: Water containing a wetting agent or surfactant with a maximum surface tension of 2.9 Pa 29 dynes per centimeter when tested in accordance with ASTM D 1331.
3. Area Sampling: Sampling of asbestos fiber concentrations which approximates the concentrations of asbestos in the theoretical breathing zone but is not actually collected in the breathing zone of an employee.
4. Asbestos: The term asbestos collectively refers to a naturally occurring mineral known by the following specific names: chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.
5. Asbestos control Area: That area where asbestos removal operations are performed. The area shall be isolated by physical boundaries to assist in the prevention of the uncontrolled access by non-qualified persons.
6. Asbestos Fibers: Those fibers having an aspect ratio of at least 3:1 and longer than-5 micrometers as determined by National Institute for Occupational Safety and Health (NIOSH) Method 7400.
7. Asbestos Permissible Exposure Limit: 0.1 fibers per cubic centimeter of air as an e-hour time weighted average measured in the breathing zone as by defined 29 CFR 1926.1101 or other Federal legislation having legal jurisdiction for the protection of workers health.
8. Background: The ambient airborne asbestos concentration in an uncontaminated area as measured prior to any asbestos hazard abatement efforts. Background concentrations for contaminated areas are measured in similar but asbestos free locations.
9. Contractor: The Contractor is that individual, or entity under contract to the Owner to perform the herein listed work.
10. Contractor/Supervisor (Asbestos abatement): A person who has successfully completed training and is therefore accredited as a Contractor/Supervisor under a State Model Accreditation Plan or EPA Model Accreditation Plan as described in 40 CFR 763.
11. Critical Barrier: The layer of polyethylene sheeting that covers an opening or penetration in a room or area that is to become a negative pressure enclosure.
12. Encapsulation: The abatement of an asbestos hazard through the appropriate use of chemical encapsulants.
13. Encapsulants: Specific materials in various forms used to chemically or physically entrap asbestos fibers in various configurations to prevent these fibers from becoming airborne. There are four types of encapsulants as follows which must comply with performance requirements as specified herein.
  - a. Removal Encapsulant (can be used as a wetting agent)
  - b. Bridging Encapsulant (used to provide a tough, durable surface coating to asbestos containing material)
  - c. Penetrating Encapsulant (used to penetrate the asbestos containing material encapsulating all asbestos fibers and preventing fiber release due to routine mechanical damage)
  - d. Lock-Down Encapsulant (used to seal off or "lock-down" minute asbestos fibers left on surfaces from which asbestos containing material has been removed).
14. Friable Asbestos Material: Any material containing more than one percent asbestos that can be crumbled, pulverized, or reduced to powder by hand pressure when dry.



15. Glovebag Technique: Those asbestos removal and control techniques put forth in 29 CFR 1926.1101.
16. HEPA Filter Equipment: High efficiency particulate air (HEPA) filtered vacuum and/or exhaust ventilation equipment with a filter system capable of collecting and retaining asbestos fibers. Filters shall retain 99.97 percent of particles 0.3 microns or larger as indicated in UL 586.
17. the Owner: That qualified person employed directly by the Owner to monitor, sample, inspect the work, and advise the Owner.
18. Negative Pressure Enclosure (NPE): That engineering control technique described as a negative pressure enclosure in 29 CFR 1926.1101.
19. Non-friable Asbestos Material: Material that contains asbestos in which the fibers have been immobilized by a bonding agent, coating, binder, or other material so that the asbestos is well bound and will not normally release asbestos fibers during any appropriate use, handling, storage or transportation. It is understood that asbestos fibers may be released under other conditions such as demolition, renovation, removal, or mishap.
20. Personal Sampling: Air sampling which is performed to determine asbestos fiber concentrations within the breathing zone of a specific employee, as performed in accordance with 29 CFR 1926.1101.
21. Competent Person (CP): A person who has successfully completed training and is therefore accredited under a legitimate State Model Accreditation Plan or EPA Model Accreditation Plan as described in 40 CFR 763 as a Contractor/Supervisor and shall be appropriately licensed according to the Statutes of the State in which the work is to be performed.
22. TEM: Refers to Transmission Electron Microscopy.
23. Time Weighted Average (TWA): The TWA is an 8-hour time weighted average airborne concentration of asbestos fibers.
24. Wetting Agent: A chemical added to water to reduce the water's surface tension thereby increasing the water's ability to soak into the material to which it is applied. An equivalent wetting agent must have a surface tension of at most 2.9 Pa 29 dynes per centimeter when tested in accordance with ASTM D 1331.

#### C. Requirements

1. Description of Work: The work covered by this section includes the handling and control of asbestos containing materials and describes some of the resultant procedures and equipment required to protect workers, the environment and occupants of the building or area, or both, from contact with airborne asbestos fibers. The work also includes the disposal of any asbestos containing materials generated by the work. More specific operational procedures shall be outlined in the Asbestos Hazard Abatement Plan called for elsewhere in this specification. The asbestos work includes the use of non-friable removal technique(s) which is governed by 40 CFR 763 as indicated. Provide non-friable removal technique(s) as outlined in this specification for the locations indicated.
2. Medical Requirements: Provide medical requirements including but not limited to medical surveillance and medical record keeping as listed in 29 CFR 1926.1101.
  - a. Medical Examinations: Before exposure to airborne asbestos fibers, provide workers with a comprehensive medical examination as required by 29 CFR 1926.1101 or other pertinent State or local directives. This requirement must have been satisfied within the 12 months prior to the start of work on this contract. The same medical examination shall be given on an annual basis to employees engaged in an occupation involving asbestos and within 30 calendar days before or after the termination of employment in such occupation. Specifically identify x-ray films of asbestos workers to the consulting radiologist and mark medical record jackets with the word "ASBESTOS."
  - b. Medical Records: Maintain complete and accurate records of employees' medical examinations, medical records, and exposure data for a period of 30 years after termination of employment and make records of the required medical examinations and exposure data available for inspection and copying to: The Assistant Secretary of Labor for Occupational



- Safety and Health (OSHA), or authorized representatives of them, and an employee's physician upon the request of the employee or former employee.
- c. Medical Certification: Submit written certification for each worker and contractor/supervisor, signed by a licensed physician indicating that the worker and contractor/supervisor has met or exceeded all of the medical prerequisites listed herein and in 29 CFR 1926.1101 and 29 CFR 1910.134 as prescribed by law.
3. Training: Train all personnel involved in the asbestos control work in accordance with United States Environmental Protection Agency (USEPA) Asbestos Hazard Emergency Response Act (AHERA) training criteria or State training criteria whichever is more stringent. The Contractor shall document the training by providing a copy of a current training certification to the the Owner for each person assigned to work on this project. Furnish each employee with respirator training and fit testing documentation as required by 29 CFR 1910.134. Provide instruction on the engineering and other hazard control techniques and procedures to be used on this project.
    - a. Employee Training: Submit copies of training certificates for each employee indicating that the employee has received training at the appropriate level in accordance with 40 CFR 763.
  4. Permits, Licenses, and Notifications: Notify the local air pollution control district/agency and the the Owner in writing 10 working days prior to commencement of work in accordance with 40 CFR 61-SUBPART M or applicable state and local regulations. Obtain necessary permits or licenses in conjunction with asbestos removal, encapsulation, hauling, and disposal. Post the permit and/or license at the work site, visible from a non-controlled area. Notify the local fire department 3 days prior to removing fire-proofing material from the building including notice that the material contains asbestos.
  5. Environment, Safety and Health Compliance: Comply with the applicable requirements of the current issue of 29 CFR 1926.1101, 40 CFR 61-SUBPART A, and 40 CFR 61-SUBPART M or applicable State or local regulations regarding handling, storing, transporting, and disposing of asbestos waste materials. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting the work. Where the requirements of this specification, applicable regulations, or referenced documents vary, the most stringent requirement shall apply.
    - a. Site Inspection: While performing asbestos engineering control work, the Contractor shall be subject to on-site inspection by the Federal, State, or local regulatory agencies and the Contracting Officer or its designated representative. If the work is found to be in violation of Federal, State, or local regulations or this specification, the Contracting Officer or its representative will issue a stop work order to be in effect immediately and until the violation is resolved. All related costs including standby time required to resolve the. violation shall be at the Contractor's expense.
  6. Respiratory Protection Program: Establish and implement a respirator program as required by ANSI 288.2 and 29 CFR 1910.134. Submit a written program manual or operating procedure including methods of compliance with regulatory statutes.
    - a. Respirator Program Records: Submit records of the respirator program as required by ANSI 288.2 and 29 CFR 1910.134.
  7. Contractor/Supervisor (Asbestos Abatement): The Contractor shall be represented on-site by a trained contractor/Supervisor. This person shall be on-site at all times when asbestos work is in progress. The Qualified Person, as defined herein, can be the Contractor/Supervisor.
  8. Hazard Communication: Adhere to all parts of 29 CFR 1910.1200 and 29 CFR 1926.59. Provide the Contracting Officer with a copy of the Material Safety Data Sheets (MSDS) for all materials brought to the site. Review the Asbestos Survey Report(s) provided by the the Owner, if any.
  9. Asbestos Hazard Abatement Plan: Submit a detailed plan of the safety precautions such as lockout, tag-out, tryout, fall protection, and confined space entry procedures and equipment and work procedures to be used in the removal of materials containing asbestos. The plan shall be prepared by the Contractor (and reviewed and signed by an asbestos consultant (LAC) licensed according to the Statutes of the State in which the work is to be performed) for review and recommendation for approval by the the Owner. The plan shall be forwarded to the the Owner for final approval at least 10 days prior to beginning abatement activities. The plan shall include but not be limited to the detailed description of personal protective equipment and work practices to



be used including, but not limited to, respiratory protection, type of whole-body protection, the location of asbestos control areas including clean and dirty areas, buffer zones, showers, storage areas, change rooms, removal method, interface of trades involved in the construction, sequencing of asbestos related work, disposal plan, type of wetting agent and asbestos encapsulant to be used, locations of local exhaust equipment, planned air sampling strategies, and a detailed description of the method to be employed in order to control environmental pollution. The plan shall also include both fire and medical emergency response plans. The Asbestos Hazard Abatement Plan must be approved in writing prior to starting any asbestos work.

10. Testing Laboratory: Submit the name, address, and telephone number of each testing laboratory selected for the sampling, analysis, and reporting of airborne concentrations of asbestos fibers along with evidence that each laboratory selected holds the appropriate State license and/or permits and certification that each laboratory is American Industrial Hygiene Association (AIHA) accredited and that persons counting the samples have been judged proficient by current inclusion on the AIHA Asbestos Analysis Registry (AAR) and successful participation of the laboratory in the Proficiency Analytical Testing (PAT) Program. Where analysis to determine asbestos content in bulk materials or transmission electron microscopy is required, submit evidence that the laboratory is accredited by the National Institute of Science and Technology (NIST) under National Voluntary Laboratory Accreditation Program (NVLAP) for asbestos analysis.
11. Landfill Approval: Submit written evidence that the landfill for disposal is approved for asbestos disposal by the USEPA and State and local regulatory agency(s).
12. Waste Shipment Records/Asbestos Waste Manifest: Submit waste shipment records and/or asbestos manifest records, prepared in accordance with applicable Federal, State, or local regulations, signed and dated by an agent of the landfill, certifying the amount of asbestos materials delivered to the landfill, within 3 days after delivery.
13. Negative Exposure Assessment: Submit objective data demonstrating that the method(s) used for the specified non-friable ACM removal does not release airborne concentrations of asbestos fibers exceeding the TWA PEL or excursion limit. This data may be from previous work within the last 12 months or from initial exposure assessments on this project. Data from previous work must have been gathered by the firm employed on this contract, using workers trained to the same level, with the ACM and workplace conditions "closely resembling" the conditions for this contract.
14. Contractor Daily Reports: Prepare a written report for each day that asbestos work is being accomplished. The report should be submitted to the the Owner monthly. The report as a minimum shall include the following, where applicable:
  - a. Daily Visual Inspection Reports: Prepare a written report documenting compliance with the Asbestos Hazard Abatement Plan and Federal, State, or local regulations.
  - b. Air Sampling Reports: Complete fiber counting within 24 hours of the "time off" of the sample pump. Notify the the Owner immediately of any airborne levels of asbestos fibers in excess of the acceptable limits. Sampling results shall be submitted to the the Owner the day following receipt. The affected employees will be provided copies of the results where required by law within 3 working days. These results shall be signed by the air sampler and the testing laboratory employee that analyzed the sample.
  - c. Pressure Differential Recordings for Local Exhaust System-Not Used
  - d. Asbestos Disposal Quantity Report: The Contractor shall record and report daily the amount of asbestos containing material removed and the amount transported for disposal. Deliver the report for the previous day and cumulative totals with amounts of material removed reported in linear meters or square meters linear feet or square feet as described initially in this specification and the amounts of material transported for disposal reported in cubic meters yards.

#### D. Submittals

1. Submit the following in accordance with Section "Submittal Procedures."
  - a. Vacuums and tools



- b. Respirators
- c. Wetting Agent
- d. Material Safety Data Sheets (MSDS) for all materials proposed for transport to the project site
- e. Local exhaust system
- f. Pressure differential automatic recording instrument
- g. Daily Reports
- h. Asbestos hazard abatement plan
- i. Testing laboratory
- j. Training Certificates
- k. Landfill approval
- l. Employee training
- m. Medical certification requirements
- n. Waste shipment records/Asbestos waste manifest
- o. Respiratory Protection Program
- p. Negative Exposure Assessment
- q. Local Exhaust system
- r. Show compliance with ANSI Z9.2 by providing manufacturers' certifications.
- s. Permits, licenses, and Notifications
- t. Rental equipment
- u. Respirator program records
- v. Protective clothing decontamination quality control records
- w. Protective clothing decontamination facility notification.

E. Quality Assurance

1. Glovebags-Not Used
2. Rental Equipment: Provide a copy of the written notification to the rental company concerning the intended use of the equipment and the possibility of asbestos contamination of the equipment.
3. Protective Clothing Decontamination Quality Control Records: Provide all records that document quality control for the decontamination of reusable outer protective clothing.
4. Protective Clothing Decontamination Facility Notification: Submit written evidence that persons who decontaminate, store, or transport asbestos contaminated clothing used in the performance of this contract were duly notified in accordance with 29 CFR 1926.1101.

1.2 PRODUCTS

A. Encapsulants

1. See Division 21 Section "Facility Fire-suppression Water-service Piping".

1.3 EXECUTION

A. Equipment

1. Respirators: Select respirators from those approved by the National Institute for Occupational Safety and Health (NIOSH). Provide personnel engaged in pre-cleaning, cleanup, handling, and removal of asbestos containing materials with the appropriate respiratory protection as specified in 29 CFR 1910.134.
2. Exterior Whole Body Protection
  - a. Outer Protective Clothing: Provide personnel exposed to asbestos with disposable "non-breathable," or reusable "non-breathable" whole body outer protective clothing, head coverings, gloves, and foot coverings. Provide disposable plastic or rubber gloves to protect hands. Cloth gloves may be worn inside the plastic or rubber gloves for comfort, but shall not be used alone. Make sleeves secure at the wrists, make foot coverings secure at the ankles, and make clothing secure at the neck by the use of tape. Reusable whole body



- outer protective clothing shall be either disposed of as asbestos contaminated waste upon exiting from the asbestos regulated work area or be properly decontaminated.
- b. Work Clothing-Not Used
  - c. Decontamination of Reusable Outer Protective Clothing: When reusable outer protective clothing is used, transport the double bagged clothing to a previously notified commercial/industrial decontamination facility for decontamination. Perform non-destructive testing to determine the effectiveness of asbestos decontamination. If representative sampling is used, ensure the statistical validity of the sampling results. If representative sampling is used, reject any entire batch in which any of the pieces exceed 40 fibers per square millimeter. Inspect reusable protective clothing prior to use to ensure that it will provide adequate protection and is not or is not about to become ripped, torn, deteriorated, or damaged, and that it is not visibly contaminated. Notify, in writing, all personnel involved in the decontamination of reusable outer protective clothing as indicated in 29 CFR 1926.1101.
  - d. Eye Protection: Provide goggles to personnel engaged in asbestos abatement operations when the use of a full face respirator is not required.
3. Warning Signs and Labels: Provide bilingual warning signs printed in English and Spanish at all approaches to asbestos control areas. Locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Provide labels and affix to all asbestos materials, scrap, waste, debris, and other products contaminated with asbestos.
- a. Warning Sign: Provide vertical format conforming to 29 CFR 1926.1101 minimum 20 by 14 inches (500 by 355 mm) displaying the following legend in the lower panel:

<u>Legend</u>	<u>Notation</u>
Danger	25 mm one inch Sans Serif Gothic or Block
Asbestos	25 mm one inch Sans Serif Gothic or Block
Cancer and Lung Disease Hazard	6 mm 1/4 inch Sans Serif Gothic or Block
Authorized Personnel only Respirators and Protective Clothing are Required in this Area	6 mm 1/4 inch Gothic 6 mm 1/4 inch Gothic

Spacing between lines shall be at least equal to the height of the upper of any two lines.

- b. Warning Labels: Provide labels conforming to 29 CFR 1926.1101 of sufficient size to be clearly legible, displaying the following legend:

**DANGER**  
**CONTAINS ASBESTOS FIBERS**  
**AVOID CREATING DUST**  
**CANCER AND LUNG DISEASE HAZARD**  
**BREATHING ASBESTOS DUST MAY**  
**CAUSE SERIOUS BODILY HARM**

- 4. Vacuums and Tools: Vacuums shall be leak proof to the filter and equipped with HEPA filters. Filters on vacuums shall conform to ANSI Z9.2 and UL 586. Do not use power tools to remove asbestos containing materials unless the tool is equipped with effective, integral HEPA filtered exhaust ventilation systems. Remove all residual asbestos from reusable tools prior to storage or reuse.

B. General



1. Pre-Asbestos Work Conference: The Contractor and the Contractor/Supervisor shall meet with the Contracting officer prior to beginning work, to discuss in detail the Asbestos Hazard Abatement Plan, including work procedures and safety precautions. Once approved by the Owners Engineer, the plan will be enforced as if a part of this specification. Any changes required in the specification as a result of the plan shall be identified specifically in the plan to allow for free discussion and approval by the Owners Engineer prior to starting work.
  2. Asbestos Control Area Requirements: The Contractor shall demarcate the asbestos control area(s) using physical barriers and signs to prevent access by unauthorized personnel. This area is defined by 29 CFR 1926.1101 as the regulated area.
  3. Work Procedure: Perform asbestos related work in accordance with 29 CFR 1926.1101, 40 CFR 61-SUBPART M, applicable State or local regulation, and as specified herein. Use wet removal procedures. Personnel shall wear and utilize protective clothing and equipment as specified herein. Eating, smoking, drinking, chewing gum or tobacco, or applying cosmetics shall not be permitted in the asbestos control area(s). Personnel of other trades not engaged in the removal of asbestos containing material shall not be exposed at any time to airborne concentrations of asbestos. If an asbestos fiber release or spill, stop work immediately, correct the condition to the satisfaction of the Owners Engineer, including clean-up and clearance sampling, if appropriate, prior to resumption of work.
  4. Furnishings: Furniture will be removed from the area of work by the Owner before asbestos work begins.
  5. Pre-cleaning: Wet wipe and HEPA vacuum all surfaces potentially contaminated with asbestos prior to establishment of an enclosure.
- C. Removal Procedures: Wet asbestos containing material with a fine spray of amended water during removal, cutting, or other handling so as to reduce the emission of airborne fibers. Remove material and immediately place in 0.15 mm 6 mil plastic disposal bags. Remove asbestos containing material in a gradual manner, with continuous application of the amended water in such a manner that no asbestos material is disturbed prior to being adequately wetted. Where unusual circumstances prohibit the use of 0.15 mm 6 mil plastic bags, submit an alternate proposal for containment of asbestos fibers to the Owner's Engineer for approval. Asbestos containing material shall be containerized while wet. At no time shall asbestos containing material be allowed to accumulate or become dry. Handle asbestos containing material as indicated in 40 CFR 61-SUBPART M, applicable State or local regulation, and 29 CFR 1926.1101.
1. Exposed Pipe Insulation Edges-Not Used
  2. Negative Pressure Enclosure: Block and seal openings in areas where the release of airborne asbestos fibers can be expected. Establish an asbestos negative pressure enclosure with the use of curtains, portable partitions, or other enclosures in order to prevent the escape of asbestos fibers from the contaminated asbestos work area.
    - a. Personnel/Equipment Decontamination Unit: Provide a temporary facility with a separate equipment/dirty change room and clean change room. Provide a shower that complies with 29 CFR 1926.51 in between the dirty room and clean room for personnel required to wear whole body protective clothing. Provide two separate lockers for each asbestos worker, one in each locker room. Keep street clothing and street shoes in the clean locker. HEPA vacuum and remove asbestos contaminated disposable protective clothing while still wearing respirators at the boundary of the asbestos work area and seal in impermeable bags or containers for disposal. Do not wear work clothing between home and work. All employees shall shower before changing into street clothes. Collect used shower water and filter with approved water filtration equipment to remove asbestos contamination. Dispose of filters and residue as asbestos waste. Discharge clean water to the sanitary system. Dispose of asbestos contaminated work clothing as asbestos contaminated waste or properly decontaminate as specified in the Asbestos Hazard Abatement Plan.
    - b. Waste Load-Out Unit: Provide a separate temporary area expressly for short-term storage of bagged asbestos containing material that is ready for disposal. The unit shall be the only port used to transfer waste to a truck, dumpster, or other approved on-site storage facility. It



shall not be used for personnel egress. A waste load-out unit shall be integral to each negative pressure enclosure.

3. Non-friable Removal Procedures:

- a. Under normal conditions EPA Category II, non-friable asbestos containing materials may not be considered hazardous; however, this material may release airborne asbestos fibers during demolition and removal; therefore it must be handled in a manner to prevent the release of asbestos fibers. At no time will this material be mechanically chipped, sawed, sanded, or ground.
- b. Prior to beginning removal, establish an Asbestos Control Area and install Critical Barriers as specified elsewhere in this section. Submit a Negative Exposure Assessment which is less than 12 months old to the the Owner for approval or conduct air sampling as specified elsewhere in this section to establish the exposure levels for the exact removal method being used. The Contractor will establish the correct level of Personal Protective Equipment required.
- c. Acceptable methods of removal include, but are not limited to, the use of dry ice, a heat gun or lamp, citrus-based solvents, and hand tools with amended water. Removal shall be accomplished to keep the ACM substantially intact. Breakage into small pieces is an unacceptable work practice. The method shall be detailed in the Asbestos Abatement Plan and shall not be changed during the removal without Contracting Officer approval.
- d. Upon completion of the removal and clean-up, but prior to removal of critical barriers, the Contractor Testing company shall conduct a visual inspection of all areas affected by the removal. Re-clean as required.

D. Field Quality Control Requirements

1. Visual Inspections: The the Owner will conduct periodic inspections of all areas where asbestos removal and activities are in progress to ensure compliance with the approved Asbestos Hazard Abatement Plan and Federal/State regulatory requirements. This inspection shall include confirmation of proper control/containment/enclosure, worker protection, housekeeping, exhaust equipment operation, decontamination procedures, proper wetting and disposal, and inspection of work progress and work practices. Each activity will be documented as acceptable or noted as unacceptable with justification for the non-compliance.
2. Air Sampling: Sampling of airborne concentrations of asbestos fibers shall be performed in accordance with 29 CFR 1926.1101 and as specified herein. Unless otherwise specified, use NIOSH Method 7400 for sampling and analysis. Air Sampling may be duplicated by the Government at the discretion of the Contracting Officer. If the air sampling results obtained by the Government differ from those results obtained by the Contractor, the Government will determine which results predominate.
  - a. Sampling Prior to Asbestos Work (Not Used)
  - b. Sampling During Asbestos Work
    - 1) The Contractor's testing company shall perform area sampling as indicated in 29 CFR 1926.1101 and governing environmental regulations. Perform area sampling at least once every week close to the work inside the enclosure, outside the personnel/equipment decontamination unit entrance to the enclosure.
    - 2) If sampling outside the enclosure shows airborne levels have exceeded background or 0.01 fibers per cubic centimeter, whichever is greater, stop all work, correct the condition(s) causing the fiber release, and notify the the Owner immediately. Determine by testing if adjacent areas are contaminated. If so the Contractor shall clean the contaminated areas, visually inspect, and sample the areas as specified herein.
    - 3) The Contractor shall conduct personal sampling of at least 25% of the workers engaged in asbestos handling (removal, disposal, transport and other associated work) throughout the duration of the project. If the quantity of airborne asbestos fibers monitored at the breathing zone of the workers at any time exceeds 0.1 fibers



per cubic centimeter, notify the PQP immediately, evaluate work practices, and take corrective action to reduce airborne asbestos fibers.

E. Clean-Up And Disposal

1. Housekeeping

- a. Essential parts of asbestos dust control are housekeeping and clean-up procedures. Maintain surfaces of the asbestos control area free of accumulations of asbestos fibers. Give meticulous attention to restricting the spread of dust and debris; keep waste from being distributed over the general area. Use HEPA filtered vacuum cleaners. **DO NOT BLOW DOWN THE SPACE WITH COMPRESSED AIR.** All asbestos waste shall be placed in an approved on-site storage facility or transported for disposal daily. When asbestos removal is complete, all asbestos waste is removed from the work-site, and final clean-up is completed, the PQP shall visually inspect the asbestos control area for cleanliness. After final clean-up and acceptable pre-clearance airborne concentrations are attained but before the local exhaust system is turned off and the negative pressure enclosure removed), remove all pre-filters on the building HVAC system and provide new pre-filters.
- b. Dispose of filters as asbestos contaminated materials. Reestablish HVAC, mechanical, and electrical systems in proper working order.

2. Title to Materials: All waste materials, except as specified otherwise, shall become the property of the Contractor and shall be disposed of as specified in applicable Federal, State, and local regulations and herein.

3. Disposal of Asbestos

- a. Collect all removed asbestos containing material, contaminated materials, contaminated water, scrap, debris, bags, containers, expendable equipment, and asbestos contaminated clothing which may produce airborne asbestos fibers and place in sealed fiber-proof, waterproof, non-returnable containers (e.g. double plastic bags 0.15 mm 6 mils thick, cartons, drums or cans). Wastes within the containers must be adequately wet in accordance with 40 CFR 61-SUBPART M. Affix a warning and Department of Transportation (DOT) label to each container including the bags or use at least 0.15 mm 6 mils thick bags with the approved warnings and DOT labeling preprinted on the bag.
- b. Each container or bag shall clearly indicate that the waste generator is the Owner and the development at which the waste is generated, and the Job Order number of the project.
- c. Prevent contamination of the transport vehicle (especially if the transport vehicle is a rented truck likely to be used in the future for non-asbestos purposes). These precautions include lining the vehicle cargo area with plastic sheeting (similar to work area enclosure) and thorough cleaning of the cargo area after transport and unloading of asbestos debris is complete. Dispose of waste asbestos material at an Environmental Protection Agency (EPA) or State-approved asbestos landfill off the Owner's property. For temporary storage, store sealed impermeable bags in asbestos waste drums or skids. An area for interim storage of asbestos waste-containing drums or skids will be coordinated with the the Owner. Procedure for hauling and disposal shall comply with 40 CFR 61-SUBPART M, State, regional, and local standards. Sealed plastic bags may be dumped from drums into the burial site unless the bags have been broken or damaged. Damaged bags shall remain in the drum and the entire contaminated drum shall be buried. Uncontaminated drums may be recycled. Workers unloading the sealed drums shall wear appropriate respirators and personal protective equipment when handling asbestos materials at the disposal site.

END OF SECTION 02 82 33 00a



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02 82 33 00	01 22 16 00	No Specification Required
02 82 33 00	02 81 00 00a	Disposal Of Hazardous Materials
02 82 33 00	02 82 16 00	Encapsulation (Lock-Down) Of Asbestos-Containing Materials



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**SECTION 02 83 19 13 - REMOVAL AND DISPOSAL OF LEAD-CONTAINING PAINT**

## 1.1 GENERAL

## A. Description Of Work

1. This specification covers the removal and disposal of lead-based or lead-containing paint. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

## B. Definitions

1. Action Level: Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8 hour period in an occupational/industrial environment.
2. Area Sampling: Sampling of lead concentrations within the lead control area and inside the physical boundaries which is representative of the airborne lead concentrations but is not collected in the breathing zone of personnel.
3. Competent Person (CP): As used in this section, refers to a person employed by the Contractor who is trained in the recognition and control of lead hazards in accordance with current federal, State, and local regulations. An industrial hygienist or safety professional certified for comprehensive practice by the American Board of Industrial Hygiene or by the Board of Certified Safety Professionals is the best choice.
4. Contaminated Room: Room for removal of contaminated personal protective equipment (PPE).
5. Decontamination Shower Facility: That facility that encompasses a clean clothing storage room, and a contaminated clothing storage and disposal rooms, with a shower facility in between.
6. Eight-Hour Time Weighted Average (TWA): Airborne concentration of lead to which an employee is exposed, averaged over an 8 hour workday as indicated in 29 CFR 1926.62.
7. High Efficiency Particulate Air (HEPA) Filter Equipment: HEPA filtered vacuuming equipment with a UL 586 filter system capable of collecting and retaining lead-contaminated paint dust. A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron or larger size particles.
8. Lead: Metallic lead, inorganic lead compounds, and organic lead soaps.
9. Lead-Based Paint (LBP): Paint or other surface coating that contains lead in excess of 1.0 milligrams per centimeter squared or 0.5 percent by weight.
10. Lead-Based Paint Hazard (LBP Hazard): Any condition that causes exposure to lead from lead-contaminated dust, lead-contaminated soil, lead-based paint that is deteriorated or present in accessible surfaces, friction surfaces, or impact surfaces that would result in adverse human health effects.
11. Lead-Containing Paint (LCP): Lead-based paint or other similar surface coating containing lead or lead compound in excess of 0.06 percent by weight of the total nonvolatile content of the paint.
12. Lead Control Area: An enclosed area or structure, constructed as a temporary containment equipped with HEPA filtered local exhaust, which prevents the spread of lead dust, paint chips, or debris existing as a condition of lead-based paint removal operations. The lead control area is also isolated by physical boundaries to prevent unauthorized entry of personnel.
13. Lead Permissible Exposure Limit (PEL): Fifty micrograms per cubic meter of air as an 8 hour time weighted average as determined by 29 CFR 1926.62. If an employee is exposed for more than eight hours in a work day, the PEL shall be determined by the following formula:  
$$\text{PEL (micrograms/cubic meter of air)} = 400/\text{No. hrs. worked per day.}$$
14. Personal Sampling: Sampling of airborne lead concentrations within the breathing zone of an employee to determine the 8 hour time weighted average concentration in accordance with 29 CFR 1926.62. Samples shall be representative of the employees' work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches (150 to 225 mm) and centered at the nose or mouth of an employee.



15. Physical Boundary: Area physically roped or partitioned off around an enclosed lead control area to limit unauthorized entry of personnel. As used in this section, "inside boundary" shall mean the same as "outside lead control area but inside boundary."

C. Submittals: Submit the following:

1. Product Data:
  - a. Vacuum filters
  - b. Respirators
2. Test Reports
  - a. Sampling results
  - b. Assessment data report
3. Certificates
  - a. Qualifications of CP
  - b. Testing laboratory</SUB> qualifications
  - c. Third party consultant qualifications
  - d. Lead-Based Paint/Lead-Containing Paint Removal Plan including CP approval (signature, date, and certification number)
  - e. Rental equipment notification
  - f. Respiratory protection program
  - g. Hazard communication program
  - h. EPA approved hazardous waste treatment or disposal facility for lead disposal
  - i. Hazardous waste management plan
  - j. Vacuum filters
4. Manufacturer's Instructions
  - a. Chemicals and equipment
  - b. Materials
  - c. Material safety data sheets for all chemicals
5. Closeout Submittals
  - a. Completed and signed hazardous waste manifest from treatment or disposal facility
  - b. Certification of medical examinations
  - c. Employee training certification

D. Qualifications Of CP

1. Submit name, address, and telephone number of the CP selected to perform responsibilities specified in paragraph entitled "Competent Person (CP) Responsibilities." Provide previous experience of the CP. Submit proper documentation that the CP is trained and licensed and certified in accordance with Federal, State, and local laws.

E. Third Party Consultant Qualifications

1. Submit the name, address, and telephone number of the third party consultant selected to perform the wipe sampling for determining concentrations of lead in dust or soil sampling. Submit proper documentation that the consultant is trained and certified as an inspector technician or inspector/risk assessor by the USEPA authorized State (or local) certification and accreditation program.

F. Testing Laboratory

1. Submit the name, address, and telephone number of the testing laboratory selected to perform the air and wipe and soil sampling, testing, and reporting of airborne concentrations of lead. Use a laboratory accredited under the EPA National Lead Laboratory Accreditation Program (NLLAP) by either the American Association for Laboratory Accreditation (A2LA) or the American Industrial Hygiene Association (AIHA) and that is successfully participating in the Environmental Lead Proficiency Analytical Testing (ELPAT) program to perform sample analysis.

G. Lead-Based Paint/Lead-Containing Paint Removal Plan (LBP/LCPRP)



1. Submit a detailed job-specific plan of the work procedures to be used in the removal of LBP/LCP. The plan shall include a sketch showing the location, size, and details of lead control areas, location and details of decontamination facilities, viewing ports, and mechanical ventilation system. Include in the plan, eating, drinking, smoking and sanitary procedures, interface of trades, sequencing of lead related work, collected waste water and paint debris disposal plan, air sampling plan, respirators, personal protective equipment, and a detailed description of the method of containment of the operation to ensure that airborne lead concentrations of 30 micrograms per cubic meter of air and baseline lead dust/soil concentrations are not reached or exceeded outside of the lead control area. Include site preparation and cleanup procedures. Include occupational and environmental sampling, training and strategy, sampling methodology, frequency, duration of sampling, and qualifications of sampling personnel in the air sampling portion of the plan.
- H. Occupational And Environmental Sampling Results
1. Submit occupational and environmental sampling results to the the Owner within three working days of collection, signed by the testing laboratory responsible official, the employee that performed the sampling, and the CP.
    - a. The sampling results shall represent each job classification, or if working conditions are similar to previous jobs by the same employer, provide previously collected exposure data that can be used to estimate worker exposures in accordance with 29 CFR 1926.62. The data shall represent the worker's regular daily exposure to lead.
    - b. Submit worker exposure data conducted during the task based trigger operations of 29 CFR 1926.62.
    - c. The initial monitoring shall determine the requirements for further monitoring and the need to fully implement the control and protective requirements including the compliance program (LBP/LCP) in accordance with 29 CFR 1926.62.
- I. Occupational And Environmental Assessment Data Report:
1. Some LBP/LCP removal work may not require full implementation of the requirements of 29 CFR 1926.62. Based on the experience of the Contractor and/or the use of a specific process or method for performing the work, the Contractor may be able to provide historic data (previous 12 months) to demonstrate that airborne exposures are controlled below the action level. Such methods or controls shall be fully presented in the LBP/LCPRP. To reduce the full implementation of 29 CFR 1926.62, the Contractor shall provide documentation in an Assessment Data Report.
  2. Submit occupational and environmental assessment report to the the Owner prior to start of work, signed by the testing laboratory responsible official, and the CP.
    - a. Submit a report that supports the determination regarding the reduction of the need to fully implement the requirements of 29 CFR 1926.62 and supporting the LBP/LCP. The exposure assessment shall represent each job classification, or if working conditions are similar to previous jobs by the same employer, provide previously collected exposure data that can be used to estimate worker exposures in accordance with 29 CFR 1926.62. The data shall represent the worker's regular daily exposure to lead for stated work.
    - b. Submit worker exposure data conducted during the task based trigger operations of 29 CFR 1926.62 with a complete process description in supporting a negative assessment.
    - c. The initial assessment shall determine the requirement for further monitoring and the need to fully implement the control and protective requirements including the compliance program (LBP/LCPRP) in accordance with 29 CFR 1926.62.
- J. Quality Assurance
1. Medical Examinations: Initial medical surveillance as required by 29 CFR 1926.62 shall be made available to all employees exposed to lead at any time (1 day) above the action level. Full medical surveillance shall be made available to all employees on an annual basis who are or may be exposed to lead in excess of the action level for more than 30 days a year or as required by 29 CFR 1926.62. Adequate records shall show that employees meet the medical surveillance requirements of 29 CFR 1926.33, 29 CFR 1926.62, and 29 CFR 1926.103.



- a. Medical Records: Maintain complete and accurate medical records of employees for a period of at least 30 years or for the duration of employment plus 30 years, whichever is longer.
- b. Medical Surveillance: Provide medical surveillance to all personnel exposed to lead as indicated in 29 CFR 1926.62.
2. Competent Person (CP) Responsibilities
  - a. Certify training as meeting all federal, State, and local requirements.
  - b. Review and approve lead-based paint/lead-containing paint removal plan for conformance to the applicable referenced standards.
  - c. Continuously inspect lead-based paint removal work for conformance with the approved plan.
  - d. Perform air and wipe sampling.
  - e. Ensure work is performed in strict accordance with specifications at all times.
  - f. Control work to prevent hazardous exposure to human beings and to the environment at all times.
  - g. Certify the conditions of the work as called for elsewhere in this specification.
3. Training: Train each employee performing paint removal, disposal, and air sampling operations prior to the time of initial job assignment and annually thereafter, in accordance with 29 CFR 1926.21, 29 CFR 1926.62, and State and local regulations.
  - a. Training Certification: Submit a certificate for each employee, signed and dated by the approved training source, stating that the employee has received the required lead training.
4. Respiratory Protection Program
  - a. Furnish each employee required to wear a negative pressure respirator or other appropriate type with a respirator fit test at the time of initial fitting and at least annually thereafter as required by 29 CFR 1926.62.
  - b. Establish and implement a respiratory protection program as required by ANSI Z88.2, 29 CFR 1926.103, 29 CFR 1926.62, and 29 CFR 1926.55.
5. Hazard Communication Program: Establish and implement a Hazard Communication Program as required by 29 CFR 1926.59.
6. Hazardous Waste Management: The Hazardous Waste Management Plan shall comply with applicable requirements of federal, State, and local hazardous waste regulations and address:
  - a. Identification and classification of hazardous wastes associated with the work.
  - b. Estimated quantities of wastes to be generated and disposed of.
  - c. Names and qualifications of each contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and operator and a 24-hour point of contact. Furnish two copies of EPA, or State and local hazardous waste permit applications or permits or manifests, as required, and EPA Identification numbers.
  - d. Names and qualifications (experience and training) of personnel who will be working on-site with hazardous wastes.
  - e. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.
  - f. Spill prevention, containment, and cleanup contingency measures including a health and safety plan to be implemented in accordance with 29 CFR 1926.65.
  - g. Work plan and schedule for waste containment, removal and disposal. Wastes shall be cleaned up and containerized daily.
  - h. Unit cost for hazardous waste disposal according to this plan.
7. Environmental, Safety and Health Compliance: In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of Federal, State, and local authorities regarding removing, handling, storing, transporting, and disposing of lead waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1926.62. Submit matters regarding interpretation of standards to the the Owner for resolution before starting work. Where specification requirements and the referenced documents vary, the most stringent requirement shall apply.



8. Pre-Construction Conference: Along with the CP, meet with the the Owner to discuss in detail the hazardous waste management plan and the lead-based paint/lead-containing paint removal plan, including work procedures and precautions for the removal plan.

K. Equipment

1. Respirators: Furnish appropriate respirators approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services, for use in atmospheres containing lead dust. Respirators shall comply with the requirements of 29 CFR 1926.62.
2. Special Protective Clothing: Furnish personnel who will be exposed to lead-contaminated dust with proper disposable uncontaminated, reusable protective whole body clothing, head covering, gloves, and foot coverings as required by 29 CFR 1926.62. Furnish proper disposable plastic or rubber gloves to protect hands. Reduce the level of protection only after obtaining approval from the CP.
3. Rental Equipment Notification: If rental equipment is to be used during lead-based paint handling and disposal, notify the rental agency in writing concerning the intended use of the equipment. Furnish a copy of the written notification to the the Owner.
4. Vacuum Filters: UL 586 labeled HEPA filters.
5. Equipment for Owner's Personnel: Furnish the the Owner with two complete sets of personal protective equipment (PPE) daily, as required herein, for entry into and inspection of the paint removal work within the lead controlled area. Personal protective equipment shall include disposable whole body covering, including appropriate foot, head, and hand protection. PPE shall remain the property of the Contractor. Respiratory protection for the the Owner will be provided by the Owner.

L. Removal

1. Title to Materials: Materials resulting from demolition work, except as specified otherwise, shall become the property of the Contractor and shall be disposed of in accordance with Division 02 Section(s) "Selective Structure Demolition" OR "Structure Demolition", except as specified herein.

1.2 PRODUCT

A. Chemicals

1. Submit applicable Material Safety Data Sheets for all chemicals used in paint removal work. Use the least toxic product approved by the the Owner.

B. Materials

1. The soluble metal content and the total metal content shall not exceed values which would cause a material to be classified as a hazardous waste.

1.3 EXECUTION

A. Protection

1. Notification: Notify the the Owner 20 days prior to the start of any paint removal work.
2. Lead Control Area Requirements
  - a. If LBP will be removed by means which will not likely create airborne, lead-containing dust (such as careful wet scraping or chemical stripping), establish a lead control area by situating critical barriers and physical boundaries around the area or structure where LBP/LCP removal operations will be performed.
  - b. If removal practice will create airborne, lead-containing dust (such as sanding, abrasive blasting, thermal cutting, demolition, or needle gun use), utilize full containment procedures - Contain removal operations by the use of critical barriers and HEPA filtered exhaust **OR** a negative pressure enclosure system with decontamination facilities and with HEPA filtered exhaust if required by the CP, **as directed**. For containment areas larger than 1,000 square feet (100 square meters) install a minimum of two 18 inch (450 mm) square viewing



- ports. Locate ports to provide a view of the required work from the exterior of the enclosed contaminated area. Glaze ports with laminated safety glass.
3. Protection of Existing Work to Remain: Perform paint removal work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition or better.
  4. Boundary Requirements: Provide physical boundaries around the lead control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.
    - a. Physical Boundary: Provide physical boundaries around the lead control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.
    - b. Warning Signs: Provide warning signs at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1926.62.
  5. Furnishings:
    - a. The Owner will remove furniture and equipment from the building before lead-based paint removal work begins.  
**OR**  
 Furniture and equipment will remain in the building. Protect and cover furnishings or remove furnishings from the work area and store in a location approved by the the Owner.  
**OR**  
 Existing furniture and equipment is lead contaminated, decontaminate, dispose of as lead contaminated waste.
  6. Heating, Ventilating and Air Conditioning (HVAC) Systems: Shut down, lock out, and isolate HVAC systems that supply, exhaust, or pass through the lead control areas. Seal intake and exhaust vents in the lead control area with 6 mil (0.15 mm) plastic sheet and tape. Seal seams in HVAC components that pass through the lead control area. Provide temporary HVAC system for areas in which HVAC has been shut down outside the lead control area.
  7. Decontamination Shower Facility: Provide clean and contaminated change rooms and shower facilities in accordance with this specification and 29 CFR 1926.62.
  8. Eye Wash Station: Where eyes may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes shall be provided within the work area.
  9. Mechanical Ventilation System
    - a. Use adequate ventilation to control personnel exposure to lead in accordance with 29 CFR 1926.62.
    - b. To the extent feasible, use fixed local exhaust ventilation connected to HEPA filters or other collection systems, approved by the CP. Local exhaust ventilation systems shall be designed, constructed, installed, and maintained in accordance with ANSI Z9.2.
    - c. Vent local exhaust outside the building only and away from building ventilation intakes.
    - d. Use locally exhausted, power actuated, paint removal tools.
  10. Personnel Protection: Personnel shall wear and use protective clothing and equipment as specified herein. Eating, smoking, or drinking or application of cosmetics is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been appropriately trained and provided with protective equipment.
- B. Work Procedures: Perform removal of lead-based paint in accordance with approved lead-based paint/lead-containing paint removal plan. Use procedures and equipment required to limit occupational and environmental exposure to lead when lead-based paint is removed in accordance with 29 CFR 1926.62, except as specified herein. Dispose of removed paint chips and associated waste in compliance with Environmental Protection Agency (EPA), federal, State, and local requirements.
1. Personnel Exiting Procedures: Whenever personnel exit the lead-controlled area, they shall perform the following procedures and shall not leave the work place wearing any clothing or equipment worn during the work day:



- a. Vacuum themselves off.
  - b. Remove protective clothing in the contaminated change room, and place them in an approved impermeable disposal bag.
  - c. Shower **OR** Wash hands and face at the site, **as directed**, don appropriate disposable or uncontaminated reusable clothing; move to an appropriate facility; shower.
  - d. Change to clean clothes prior to leaving the physical boundary designated around the lead control area.
2. Air and Wipe Sampling
- a. Air sample for lead in accordance with 29 CFR 1926.62 and as specified herein. Air and wipe sampling shall be directed or performed by the CP.
    - 1) The CP shall be on the job site directing the air and non-clearance wipe sampling and inspecting the lead-based paint removal work to ensure that the requirements of the contract have been satisfied during the entire lead-based paint removal operation.
    - 2) Collect personal air samples on employees who are anticipated to have the greatest risk of exposure as determined by the CP. In addition, collect air samples on at least 25 percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.
    - 3) Submit results of air samples, signed by the CP, within 72 hours after the air samples are taken. Notify the the Owner immediately of exposure to lead at or in excess of the action level of 30 micrograms per cubic meter of air outside of the lead control area.
    - 4) For high profile, sensitive work such as present in family housing, child care facilities, administrative buildings, kitchens, barracks, etc., surface dust sampling to determine clearance (i.e., that the work has not contaminated surfaces within and adjacent to the control area) should be performed by a third party to reduce a conflict of interest. Samples must be conducted by an individual not paid or employed or otherwise compensated by the LBP/LCP removal Contractor. State or local regulations may require third party testing if the LBP/LCP removal operation is considered a lead hazard reduction activity.
    - 5) Before any work begins, collect and analyze baseline or soil wipe samples in accordance with methods defined in federal, State, and local standards inside and outside of the physical boundary to assess the degree of dust contamination in the facility prior to lead-based paint removal.
  - b. Air Sampling During Paint Removal Work: Conduct area air sampling daily, on each shift in which lead-based paint removal operations are performed, in areas immediately adjacent to the lead control area. Sufficient area monitoring shall be conducted to ensure unprotected personnel are not exposed at or above 30 micrograms per cubic meter of air. If 30 micrograms per cubic meter of air is reached or exceeded, stop work, correct the condition(s) causing the increased levels. Notify the the Owner immediately. Determine if condition(s) require any further change in work methods. Removal work shall resume only after approval is given by the CP and the the Owner. For outdoor operations, at least one sample on each shift shall be taken on the downwind side of the lead control area.
3. Lead-Based Paint Removal
- a. Manual or power sanding of interior and exterior surfaces is not permitted. Provide methodology for removing LBP in work plan. Remove paint within the areas designated on the drawings in order to completely expose the substrate. Take whatever precautions necessary to minimize damage to the underlying substrate.
  - b. Avoid flash rusting or deterioration of the substrate. Provide surface preparations for painting in accord with Division 07.
  - c. Provide methodology for removing LBP/LCP removal processes to minimize contamination of work areas outside the control area with lead-contaminated dust or other lead-contaminated debris/waste and to ensure that unprotected personnel are not exposed to hazardous concentrations of lead. Describe this LBP/LCP removal process in the LBP/LCPRP.



- d. Indoor Lead Paint Removal: Perform manual **OR** mechanical **OR** thermal **OR** chemical, **as directed**, paint removal in lead control areas using enclosures, barriers, or containments and powered locally exhausted paint removal tools. Collect residue and/or debris for disposal in accordance with federal, State, and local requirements.
  - e. Outdoor Lead Paint Removal: Perform outdoor removal as indicated in federal, State, and local regulations and in the LBP/CPRP. The worksite preparation (barriers or containments) shall be job dependent and presented in the LBP/LCPRP.
  - f. Sampling After Paint Removal: After the visual inspection, conduct soil sampling if bare soil is present during external removal operations and collect air samples inside and outside the lead control area to determine the airborne levels of lead inside and outside the work area. Collect wipe samples according to the HUD protocol contained in HUD Guidelines to determine the lead content of settled dust and dirt in micrograms per square foot (square meter) of surface area and parts per million (ppm) or micrograms per gram ( $\mu\text{g/g}$ ) for soil.
4. Cleanup and Disposal
- a. Cleanup: Maintain surfaces of the lead control area free of accumulations of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over the work area. Do not dry sweep or use compressed air to clean up the area. At the end of each shift and when the paint removal operation has been completed, clean the area of visible lead paint contamination by vacuuming with a HEPA filtered vacuum cleaner, wet mopping the area and wet wiping the area as indicated by the CP. Reclean areas showing dust or residual paint chips or debris. After visible dust, chips and debris is removed, wet wipe and HEPA vacuum all surfaces in the work area. If adjacent areas become contaminated at any time during the work, clean, visually inspect, and then wipe sample all contaminated areas. The CP shall then certify in writing that the area has been cleaned of lead contamination before restarting work.
  - b. Clearance Certification
    - 1) The CP shall certify in writing that the final air samples collected inside and outside the lead control area are less than 30 micrograms per cubic meter of air; the respiratory protection used for the employees was adequate; the work procedures were performed in accordance with 29 CFR 1926.62 and 40 CFR 745; and that there were no visible accumulations of material and dust containing lead left in the work site. Do not remove the lead control area or roped off boundary and warning signs prior to the the Owner's acknowledgement of receipt of the CP certification.
    - 2) A third party consultant shall certify surface wipe sample results collected inside and outside the work area are less than 100 micrograms per square foot (0.1 square meter) on uncarpeted floors, less than 500 micrograms per square foot (0.1 square meter) on interior window sills and less than 800 micrograms per square foot (0.1 square meter) on window troughs **OR** not significantly greater than the initial surface loading determined prior to work, **as directed**.
    - 3) For exterior paint removal work, soil samples taken at the exterior of the work site shall be used to determine if soil lead levels had increased at a statistically significant level (significant at the 95 percent confidence limit) from the soil lead levels prior to the work. If soil lead levels do show a statistically significant increase above any applicable Federal or State standard for lead in soil, the soil shall be remediated back to the pre-work level.
  - c. Testing of Lead-Based Paint Residue and Used Abrasive: Test paint residue and used abrasive in accordance with 40 CFR 261 for hazardous waste.
  - d. Disposal
    - 1) Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing which may produce airborne concentrations of lead particles. Label the containers in accordance with 29 CFR 1926.62 and 40 CFR 261. Dispose of lead-contaminated waste material at an EPA or State approved hazardous waste treatment, storage, or disposal facility off Owner's property.



- 2) Store waste materials in U.S. Department of Transportation (49 CFR 178) approved 55 gallon (208 liter) drums. Properly label each drum to identify the type of waste (49 CFR 172) and the date the drum was filled. The the Owner or an authorized representative will assign an area for interim storage of waste-containing drums. Do not store hazardous waste drums in interim storage longer than 90 calendar days from the date affixed to each drum.
- 3) Handle, store, transport, and dispose lead or lead-contaminated waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265. Comply with land disposal restriction notification requirements as required by 40 CFR 268.
- 4) All material, whether hazardous or non-hazardous shall be disposed in accordance with laws and provisions and Federal, State, or local regulations. Ensure waste is properly characterized. The result of each waste characterization (TCLP for RCRA materials) will dictate disposal requirements.
5. Disposal Documentation: Submit written evidence that the hazardous waste treatment, storage, or disposal facility (TSD) is approved for lead disposal by the EPA and State or local regulatory agencies. Submit one copy of the completed manifest, signed and dated by the initial transporter in accordance with 40 CFR 262.
6. Payment for Hazardous Waste: Payment for disposal of hazardous waste will not be made until a signed copy of the manifest from the treatment or disposal facility certifying the amount of lead-containing materials delivered is returned and a copy is furnished to the Owner.

END OF SECTION 02 83 19 13



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**SECTION 02 83 19 13a - LEAD PAINT RELATED ABATEMENT PROCEDURES**

## 1.1 GENERAL

## A. Description Of Work

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

## B. General Provisions

1. The site of this work will be occupied while work is being done. Perform the abatement work with the least inconvenience to the residents.
2. Take all necessary precautions to protect the property of the the Owner and its residents. Damaged property shall be repaired and restored to its original condition. If the damage is beyond repair, the Contractor shall replace it with new materials to match existing, at the Contractor's expense.
3. Hazardous waste generated during the abatement process (including lead-base paint) when carted away from the developments shall not be transferred from one vehicle to another except at a licensed transfer station.
4. Develop a work plan to be performed as requested by the the Owner. The detailed plan shall include sequencing of abatement work in a manner that will be least disruptive to the normal use of the non-work areas in the building. The plan should also include emergency procedures in case of fire.
5. The Contractor shall include all supplementary miscellaneous items not specified but implied or required in order to complete the work.
6. Workmanship required in the execution of the work herein specified shall be of good quality and subject to the approval of the the Owner.
7. Make in a timely fashion all applicable and necessary notifications to relevant Federal, State and Local authorities. The Contractor shall indemnify the the Owner and the the Owner's representative from, and pay all claims resulting from failure to adhere to these provisions.
8. the Owner may retain an independent Monitoring Contractor to monitor the abatement contract and conduct all wipe sampling and clearance tests.
9. Contractor performing lead-based paint abatement or renovation activities involving lead-based paint shall be a Certified Lead Abatement Contractor and shall ensure that supervisors and workers are trained and certified by U.S. EPA approved state program or equivalent, to perform lead paint removal operations.
10. Establish and implement a Chemical Hazard Communication Program as required by OSHA regulations 29 CFR 1926.59.
11. Provide workers with a comprehensive medical examination as required by OSHA regulations 29 CFR 1926.62 before exposure to lead contaminated dust. The medical examination shall be conducted to approve use of appropriate respirators and shall include biological monitoring. NIOSH/MSHA approved respirators shall be utilized.
12. For employees required to wear a negative pressure respirators: conduct a respirator fit test at the time of initial fitting and at least once every six (6) months thereafter as required by OSHA regulations 29 CFR 1926.62.
13. Determine if any worker will be exposed to lead at or above the action level in accordance with OSHA regulation 29 CFR 1926.62 and 29 CFR 1910.1025. Conduct an exposure assessment to identify the level of exposure a worker would be subjected to without respiratory protection. Assess the exposure level by obtaining personal monitoring samples representative of a full shift of at least an 8-hour TWA.
14. Furnish appropriate respirators approved by NIOSH/MSHA for use in atmospheres containing lead aerosols. Instruct workers in all aspects of respiratory protection. Maintain an adequate supply of HEPA filter elements and spare parts on site for all types of respirators in use.



15. For manual demolition, scraping, sanding, use of heat gun or power tool paint removal with HEPA collection systems, workers shall minimally use the half-mask negative pressure respirator with high efficiency filters (for airborne concentrations not in excess of 500 $\mu\text{g}/\text{m}^3$ ).
16. Ensure that work area preparation, work practices, and clean-up procedures comply with these specifications and applicable Federal, State and Local regulations.
17. Notify all applicable agencies five days prior to the date the abatement will begin and provide evidence of notifications to the the Owner at the pre-start meeting.

#### C. Submissions

1. Within ten (10) consecutive calendar days calculated from the date of the the Owner's Job Order, the Contractor shall tender all required submissions. Six (6) sets of each submission are required. Where physical samples are required two (2) physical samples shall be submitted for each item. In general, items shall include but not be restricted to the following:
  - a. Paint remover - corner cutter/Vac-Pac System by Pentek Inc; Decontamination Products Division 1026 Fourth Avenue, Corapolis, PA. 15108. Telephone No. (412) 262-0725 or approved equal.
  - b. Description of removal method to be used on each substrate condition including manufacturer's operating instructions and recommendation for equipment usage.
  - c. Copies of current training certificates of Staff to be assigned to the contract.
  - d. List of three previous lead abatement jobs performed successfully by Contractor and name, address, and telephone number of contact person for verification.
2. In the event that all or any portion of the submitted material is rejected by the the Owner, the Contractor shall tender new submissions. All submissions returned for corrections shall be resubmitted with the required corrections within ten(10) consecutive calendar days calculated from the date of rejection, until final submissions are obtained that require no further correction. In no event shall the Contractor be permitted to tender submissions hereunder beyond twenty (20) days from the the Owner's Job Order, unless duly extended in writing by the the Owner.
3. No work shall begin, nor shall the materials be ordered or delivered to the site until final approval of all submissions.

#### D. Applicable Regulations

1. 24 CFR Part 35
2. HUD "Guidelines For the Evaluation and Control of Lead-Based Paint Hazards in Housing"
3. Abatement work shall also be in accordance with applicable regulations of the Environmental Protection Agency (EPA), Occupational Safety & Health Agency (OSHA) and any State or Local LBP standards. Where there is a conflict between Federal, State or Local regulations, the more stringent requirement shall prevail.
4. OSHA Standards
  - a. 29 CFR 1926.20 General safety and health provisions;
  - b. 29 CFR 1926.21 Safety training and education;
  - c. 29 CFR 1925.25 Housekeeping;
  - d. 29 CFR 1926-28 Personal protective equipment;
  - e. 29 CFR 1926.51(f) Washing facilities;
  - f. 29 CFR 1926.55 Gases, vapors, fumes, dusts, and mists;
  - g. 29 CFR 1926.57 Ventilation
  - h. 29 CFR 1926.59 Hazardous Communication Standards;
  - i. 29 CFR 1926.103 Respiratory protection, and
  - j. 29 CFR 1926.62 Lead in Construction
5. The Contractor must comply with all applicable requirements of the Resource Conservation & Recovery Act (RCRA) of 1976 as amended in 1980 and 1984 by the Hazardous & Solid Waste Amendments (HSWA).
6. These Specifications refer to many requirements found in the preceding references but in no way is it intended to cite or reiterate all provisions therein or elsewhere. It is the Contractor's responsibility to obtain a copy, and know, understand and abide by all such regulations, guidelines and common practices.



## 1.2 PRODUCTS – (not used)

## 1.3 EXECUTION

## A. Abatement

1. Have risk assessment or paint inspection performed by certified risk assessor or a certified inspector technician who is independent of the abatement contractor.
2. Develop a site specific lead hazard control plan, reviewed and signed by an asbestos consultant (LAC) who is licensed in the State in which the work is to be performed, and submit for review and approval to the the Owner.
3. Obtain any necessary building or waste permits, notify local authorities as required by applicable codes and laws.
4. Select specific building component replacement items, enclosure materials, paint removal equipment and/or chemicals, tools, and cleaning supplies. Consider waste management and historical preservation implications of selected treatment.
5. Develop project specific specifications.
6. Schedule other work so that leaded surfaces are not inadvertently disturbed and unprotected workers are not place at risk. Include time for clearance examinations and laboratory dust sample analysis in the scheduling process.
7. Select a certified abatement subcontractor.
8. Conduct a pre-construction conference to ensure that the subcontractor fully understands the work involved.
9. Notify residents of the dwelling and adjacent dwellings of the work and date it will begin. Coordinate this with the the Owner.
10. Correct any existing conditions that could impede the abatement work (i.e. trash removal, structural deficiencies).
11. Post warning signs and restrict entry to work area to authorized personnel. Implement worksite preparation procedures.
  - a. Place proper warning signs required by OSHA regulations at all entrances to the work area. Signage shall be minimum of 12" x 20" and shall state the following:

**WARNING  
LEAD WORK AREA  
POISON  
NO SMOKING OR EATING**

12. Coordinate test, pilot or sample portion approach to the project with the Owner.
13. Shut-down forced air heating, ventilation and air conditioning systems and cover all vents, diffusers, windows etc., with a single layer six-mil polyethylene sheet secured with duct tape. Exceptions shall be for minor disturbances of area less than 2 square feet and where if vents, diffusers, and windows are more than 5 feet away from surface being disturbed, they need not be covered.
14. Collect preabatement soil samples, which may not have to be analyzed until post abatement soil samples have been collected, analyzed, and compared to clearance standards. If postabatement soil levels are below applicable limits, the preabatement samples need not be analyzed.
15. Cover entrances to the work area with a single layer of 6 mil polyethylene sheets taped to the top and weighted at bottom.
16. Rig a containment non-flammable polyethylene sheet underneath the work area. This containment method should catch all stripped paint for proper disposal.
17. Execute abatement work.
18. Avoid spreading dust and debris outside the work area.
19. Store all waste in a secure area and make sure it is properly labeled with an accumulation start date.
20. Conduct daily and final cleanup.
21. Execute waste disposal procedures.



22. Maintain appropriate records.

**B. Paint Removal**

1. Do not use the following prohibited paint removal methods:
  - a. Dry scraping or sanding (except for limited areas)
  - b. Use of heat gun over 1,100°F
  - c. Open flame burning or torching
  - d. Machine sanding or grinding without HEPA vacuum exhaust tool
  - e. Abrasive blasting or sandblasting without HEPA vacuum exhaust tool
  - f. Uncontained hydro blasting or high-pressure wash
  - g. Use of chemical strippers containing Methylene chloride.
2. Select the appropriate worksite preparation level.
3. For heat gun work, provide fire extinguishers in the work area and ensure that adequate electrical power is available. Use for limited areas only. Train workers to avoid gouging or abrading the substrate.
4. For mechanical removal methods, use tools equipped with HEPA exhaust capability. Be sure workers keep the shroud against the surface being treated. Vacuum blasting and needle guns should not be used on wood, plaster, drywall, or other soft substrates. Observe all manufacturers directions for the amount of vacuum airflow required.
5. For wet scraping, use a spray bottle or wet sponge attached to the scraper to keep the surface wet while scraping. Apply enough water to moisten the surface completely, but not so much that large amounts of water run onto the ground or floor. Do not moisten areas near electrical circuits.
6. For chemical paint removers, determine if the building component can be removed and stripped offsite. Offsite stripping is generally preferred to onsite paint removal. Observe all manufacturers' directions for use of paint removers.
7. For offsite stripping, determine how to remove the component. Score the edges with a knife or razor blade to minimize the damage to adjacent surfaces. Punch or tag the building component, if similar building components are also being stripped offsite (i.e. doors). This will ensure that the individual component is reinstalled in the same location. Inform the offsite paint remover that the lead-based paint component is present for shipping. Wrap the component in plastic and send to the offsite stripping location. Clean all surfaces before reinstallation and remove any lead residue by HEPA vacuuming all surfaces, cleaning with other lead-specific cleaners, or phosphate detergents, and HEPA vacuuming again.
8. For onsite paint removal, first test the product on a small area to determine its effectiveness. Chemical paint removers may not be effective or desirable on exterior, deteriorated wood surfaces, aluminum, and glass. Provide neoprene, nitrile, rubber, or polyvinyl chloride (PVC) gloves (or other type of glove recommended by the manufacture); face shields; respirators with combination filter cartridges for lead dust and organic vapors(if appropriate); and chemically resistant clothing. Be sure to select the right type of organic vapor filter cartridge, gloves, and clothing for the specific chemical being used. Portable eyewash stations capable of providing a 15-minute flow must be on-site. Apply the chemical and wait the required period of time. Securely store chemical s overnight. For caustic chemical paint removers, neutralize the surface before repainting using glacial acetic acid (not vinegar). Repaint.
9. Make sure all debris is caught in the containment sheet for proper disposal.
10. Mark and legally dispose of waste in accordance with all applicable Federal, State and Local regulations. Most wastes from paint removal projects, such as paint chips and paint remover sludge, will need to be managed as hazardous waste.
11. Conduct clean-up
12. Have a certified risk assessor or inspector technician conduct a clearance examination and provide documentation and a Statement of Lead-Based Paint Compliance.

**C. Building Component Replacement**

1. Prepare work area by selecting proper worksite preparation level.
2. Prepare the hazardous material building component for removal. Turn off and disconnect any electrical circuits inside or near the building component to be removed.



3. Lightly mist the component to be removed (unless electrical circuits are located nearby).
4. Score all painted seams with a sharp knife.
5. Remove any screw, nails, or other fasteners.
6. Use flat pry instrument and hammer to pry component from the substrate.
7. Remove or bend back all nails.
8. Wrap and seal all bulk components in plastic and take them to a covered truck or secured waste storage area along a pathway covered in plastic. Shovel any debris. Dispose of properly.
9. HEPA vacuum any dust or chips in the area where the component was located.
10. Conduct cleaning and clearance activities.

D. Soil and Exterior Dust Abatement

1. Determine if soil lead hazard exists. For hazard to exist, a total of at least 9 square feet of soil in a single yard or area must be bare and soil concentrations must exceed 2,000 $\mu$ g/gram lead for the yard or building perimeter or 400 $\mu$ g/gram of lead for small, high-contact play areas (pending the development of an EPA soil standard). Bare soil above these levels shall be treated by either interim controls or abatement. Soil abatement is most appropriate when levels of lead are extraordinarily high (greater than 5,000 $\mu$ g/gram lead) and when use patterns indicate contact frequency and exposure will be high.
2. Collect Preabatement soil samples to determine baseline levels. These samples need not be analyzed if post abatement samples are below applicable clearance levels.
3. Determine the method of soil abatement (soil removal and replacement, soil cleaning, or paving). Soil cultivation (rototilling or turning over the soil) is not permitted.
4. If paving, use a high quality concrete or asphalt. Observe normal precautions associate with traffic load weight and thermal expansion and contraction. Obtain necessary permits. Keep soil cultivation to a minimum.
5. If removing and replacing soil.
  - a. Determine if waste soil will be placed in an offsite burial pit. Prepare vehicle operation and soil movement plan. Test new replacement soil (should not contain more than 200  $\mu$ g/gram lead).
  - b. Contact local utilities to determine location of underground utilities including water, gas, cable TV, electric, telephone, and sewer. Mark all locations to be avoided
  - c. Remove fencing, if necessary to allow equipment access and define set limits with temporary fencing, signs, or yellow caution tape.
  - d. Tie and protect existing trees, shrubs, and bushes.
  - e. Have enough tools to avoid handling clean soil with contaminated tools.
  - f. Remove soil.
  - g. Clean all walkways, driveways, and street areas near abatement area.
  - h. Replace soil at proper grade to allow drainage. Replacement soil should be at least 2 inches above existing grade to allow for settling.
  - i. Install new soil covering (grass or sod) and maintain it through the growing season.
  - j. Determine if soil waste is hazardous and manage it accordingly
  - k. Conduct clean-up and clearance.
  - l. Provide walk-off doormats.
  - m. Maintain proper documentation.

E. Encapsulation

1. Determine if the applicable regulations allow encapsulation to be used. Do not encapsulate the following surfaces:
  - a. Friction surfaces, such as window jambs and door jambs.
  - b. Surfaces that fail patch tests.
  - c. Surfaces with substrates or existing coatings that have a high level of deterioration.
  - d. Surfaces in which there is a known incompatibility between two existing paint layers.
  - e. Surfaces that cannot support the additional weight stress of encapsulation due to existing paint thickness.
  - f. Metal surfaces that are prone to rust or corrosion.
2. Conduct field tests of surfaces to be encapsulated for paint film integrity.



3. Consider special use and environmental requirements (i.e. abrasion resistance and ability to span base substrate cracks).
4. Provide to the the Owner encapsulant test data provided by the manufacturer.
5. Conduct at least one test patch on each type of building component where the encapsulant will be used. Report the results to the the Owner.
6. For both nonreinforced and reinforced coatings, use a 6" x 6" test patch area. Prepare the surface in the manner selected to complete the job. Prepared surfaces for patch testing should be at least 2" larger in each direction than the patch area.
7. For fiber-reinforced wall coverings, use 3" x 3" patch. For rigid coatings that cannot be cut with a knife, use soundness test. For all encapsulants, carry out the appropriate adhesion tests.
8. For liquid coating encapsulants, allow coating to cure, then visually examine it for wrinkling, blistering, cracking, bubbling, or other chemical reaction with the underlying paint.
9. Record results of all patch tests and provide to the the Owner.
10. Implement proper work site preparation level.
11. Repair all building components and substrates as needed (i.e. caulk cracks and repair sources of water leaks).
12. Prepare surfaces. Remove all dirt, grease, chalking paint, mildew and other surface contaminants, remnants of cleaning solutions, and loose paint. All surfaces should be deglossed, as needed.
13. Ventilate the contaminated area whenever solvents or chemicals are used.
14. During encapsulant application or installation, monitor temperature and humidity. For liquid coatings monitor coating thickness to ensure that the encapsulant manufacturer's installation/application specifications are followed.
15. Conduct clean up and clearance.
16. Provide the the Owner information on how to care for the encapsulation system properly.
17. Maintain records on the exact detailed locations of encapsulant applications, patch test specifications and results, product name, subcontractor, date of application, a copy of the product label and material Data Safety sheet (MSDS) for the product and provide to the the Owner.

#### F. Enclosure

1. Stamp, label or stencil all lead-based painted surfaces that will be enclosed with a warning approximately every 2 feet both horizontally and vertically on all components. The Warning shall read "**Danger Lead-Based Paint**". Deteriorated paint should not be removed from the surface to be enclosed.
2. Select the proper worksite preparation level.
3. Attach a durable drawing to the utility room closet showing where lead-based paint has been enclosed in the dwelling.
4. An independent inspector or technician or risk assessor should evaluate the integrity of the enclosure.
5. Repair any unsound substrates and structural members that will support the enclosure, if necessary.
6. Utilize appropriate enclosure material (drywall or fiberboard, wood paneling, laminated products, ridged tile and brick veneers, vinyl, aluminum m, or plywood).
7. Install extension rings for all electrical switches and outlets that will penetrate the enclosure.
8. If enclosing floors, remove all dirt with a HEPA vacuum to avoid small lumps in the new flooring.
9. Seal and back-caulk all seams and joints. Back-caulk means applying caulk to the underside of the enclosure.
10. When installing enclosure directly to painted surfaces, use adhesive and then anchor with mechanical fasteners (screws or nails).
11. Conduct clean up and clearance activities.
12. Maintain proper records and submit a Statement of Lead-Based Paint Compliance.

#### G. Final Cleaning Procedures

1. Use the following step-by-step procedures



- a. Assign responsibilities to specific workers for cleaning and for maintaining the cleaning equipment.
  - b. Have sufficient cleaning equipment and supplies before beginning work.
  - c. If contamination is extensive, conduct precleaning of the dwelling unit.
  - d. Conduct ongoing cleaning during the job, including regular removal of large and small debris and dust. Decontamination of all tools, equipment and worker protection gear is required before it leaves contaminated areas. Electrical equipment should be wiped and high-efficiency particulate air (HEPA) vacuumed, not wetted down, to minimize electrocution hazards.
  - e. Schedule sufficient time (usually 30 minutes to an hour) for complete daily cleaning, starting at the same time near the end of every workday after lead hazard control activity has stopped.
  - f. For final cleaning, wait at least 1 hour after active lead hazard control activity has ceased to let dust particles settle.
  - g. Use a vacuum cleaner equipped with a HEPA exhaust filter. HEPA vacuum all surfaces in the room (ceilings, walls, trim, and floors). Start with the ceiling and work down, moving toward the entry door. Completely clean each room before moving on.
  - h. Wash all surfaces with lead-specific detergent, high-phosphate detergent, or other suitable cleaning agent to dislodge any ground-in contamination, then rinse. Change the cleaning solution after every room is cleaned.
  - i. Repeat step g above. To meet clearance standards consistently, a HEPA vacuum, wet wash, and HEPA vacuum cycle is recommended. For interim control projects involving dust removal only, the final HEPA vacuuming step is usually not needed. Other cleaning methods are acceptable, as long as clearance criteria are met and workers are not over exposed.
  - j. After final cleaning perform visual examination to ensure that all surfaces requiring lead hazard control have been addressed and all visible dust and debris have been removed. Record findings and correct any incomplete work.
  - k. If other construction work will disturb the lead-based paint surfaces, it should be completed at this point. If those surfaces are disturbed, repeat the final cleaning step after construction work has been completed.
  - l. Paint and otherwise seal treated surfaces and interior floors.
  - m. Conduct clearance examination.
  - n. If clearance is not achieved, repeat final cleaning.
  - o. Continue clearance testing and repeated cleanings until dwelling unit achieves compliance with all clearance standards. The cost of repeated cleaning, after failure to achieve clearance is to be borne by the contractor.
  - p. Do not allow residents to enter work area until final cleaning is completed and clearance is established.
  - q. Cleaning equipment list is as follows:
    - 1) HEPA Vacuums
    - 2) Detergent
    - 3) Waterproof gloves
    - 4) Rags
    - 5) Sponges
    - 6) Mops
    - 7) Buckets
    - 8) HEPA vacuum attachments (crevice tools, beater bar for cleaning rugs)
    - 9) 6-mil plastic bags
    - 10) Debris containers
    - 11) Waste water containers
    - 12) Shovels
    - 13) Rakes
    - 14) Water-misting sprayers
    - 15) 6-mil polyethylene sheeting (or equivalent)
2. Order of execution for final cleaning steps should be as follows:



- a. As the first stage in final cleaning, floor plastic shall be misted and swept.
- b. Upper level plastic, such as on cabinets and counters should be removed first, after it has been misted and cleaned. All plastic should be carefully folded from the corners/ends to the middle to trap any remaining dust. Next remove both layers of plastic from the floor.
- c. Plastic sheets used to isolate contaminated rooms from noncontaminated rooms should remain in place until after cleaning and removal of other plastic sheeting, these sheets may then be misted, cleaned and removed last.
- d. Removed plastic should be placed into double 4-mil or single 6-mil plastic bags, or plastic bags with equivalent (or better) performance characteristics, which are sealed and removed from the premises. As with daily cleanings, this plastic removal process usually requires workers to use protective clothing and respirators.
- e. After plastic has been removed from the contaminated area, the entire area should be cleaned using the HEPA/wet wash/HEPA cycle.

#### H. Waste Testing And Disposal

1. General: All materials, whether hazardous or non-hazardous shall be properly disposed of. the Owner may hire an independent Monitoring Consultant to perform TCLP test to determine which of the wastes are hazardous. Contractor shall cooperate in this test. If less than 100kg (200 lbs) or 1/2 of a 55 gallon drum of hazardous waste per month will be generated, it is considered "conditionally exempt" abatement waste, and may be managed as solid non-hazardous waste. The RCRA hazardous waste manifest is not required when shipping this waste to an offsite disposal facility.
2. Separate Abatement Waste into The Following Four Categories:
  - a. Category I. Low lead waste (typically non-hazardous) e.g. Filtered personal and commercial wash water.
  - b. Category II. Architectural components - (painted finish carpentry items) e.g. Doors, windows, window trim and sills, baseboards, railings, moldings. (May do a TCLP to determine if they are hazardous).
  - c. Category III. Concentrated lead waste e.g. sludge from stripping, lead-base paint chip and dust, HEPA vacuum debris and filter, unfiltered wash waste, any waste included in EPA's list of hazardous waste.
  - d. Category IV. Material that cannot be determined to be either hazardous or non-hazardous must be tested by TCLP.

If the hazardous waste generated is greater than 100kg per month, dispose according to the referenced guidelines and RCRA hazardous waste management requirements including those listed below.

3. Disposal Requirements: Contact the regional EPA, state, local and all other pertinent authorities to determine lead-based paint debris disposal requirements. Comply with requirements of the Resource Conservation and Recovery Act (RCRA) and with applicable federal, state, county, or local waste requirements.
4. EPA ID Numbers: Obtain a Generator RCRA Hazardous Material ID number and coordinate this action through the State and secure any additional number as required.
5. Storage Requirements: Keep all hazardous items in a secure area or lockable container that is inaccessible to all persons other than the Contractor's personnel. Label all hazardous waste "Hazardous Waste" with the date that the Contractor began to collect the waste in that container. Keep hazardous and non-hazardous waste in separate containers. Until TCLP testing is completed, considered all items hazardous and store in a secured area or lockable container.
6. Waste Transportation: Transport hazardous waste using a RCRA/DOT/EPA certified Hazardous Waste Transporter. Submit names and qualifications of certified transporter/hauler for the Owner approval. The Contractor shall be responsible for all actions of the waste hauler as pertaining to waste removal and disposal under these procedures and all EPA, DOT and other applicable regulations.
7. Disposal Facility: Supply documents that detail the site(s) to be used for ultimate disposal. Submit documents from these sites proving that they are licensed/permitted to accept such waste and shall accept the waste proposed by the Contractor for treatment or ultimate disposal.



8. Waste Containers: Comply with EPA and DOT regulations for waste containers. Contact the state and local authorities to determine their criteria for containers. In the case of any conflict in regulations, the more stringent shall apply.
  9. Emergencies: Contact local fire, police, hospitals or local emergency response teams and inform them of the type of hazardous waste activity and ask for assistance in the event of any accident. Additionally, the container shall provide the following:
    - a. Keep and properly maintain a suitable fire extinguisher(s) on site.
    - b. Have a immediate means of communication with the regulatory agency in the event of an emergency.
    - c. Keep a list of phone numbers of regulatory agencies on site.
    - d. Appoint an emergency coordinator and ensure the coordinator is on site to supervise emergency procedures to be carried out in the event of an emergency.
    - e. Keep and maintain a "right to know" manual that is in an easily accessible location and in an area that is known to all employees.
  10. Transporting Waste: Provide certifications that the transporter is registered with the U.S. Department of Transportation is required by 49 CFR Part 107(a) transport hazardous waste.
    - a. Provide certifications that each vehicle dedicated to haul hazardous waste has been assigned a "U.S. DOT Hazardous Material Registration Number" as required by 49 CFR Part 107.
    - b. Be responsible for all other applicable permits pertaining to hauling, transport, reduction, and disposal of hazardous waste as they may apply to this project.
    - c. Vehicle: Ensure that all non-hazardous waste is transported in covered vehicles to a landfill, or lined landfill, if required.
    - d. Container Handling: Carefully place the containers into the truck or dumpster used for disposal. At no time shall debris or containers be thrown or dropped.
    - e. Liquid Wastes: Contain and properly dispose of all liquid wastes, including lead-contaminated wash water.
    - f. Containers: HEPA vacuum the exterior of all waste containers prior to removing the waste containers from the work area. Wet wipe the containers to ensure that there is no residual contamination. Then move containers out of the work area into the designated storage area.
- I. Clearance
1. Clearance on all abatement projects must be done by an independent certified risk assessor or inspector technician. Follow all jurisdictional law with regard to licensure requirements for personnel conducting clearance activities.
  2. Clearance step-by-step procedures are as follows:
    - a. Finish the lead hazard control clean-up effort. Seal floors before clearance (if necessary).
    - b. Wait 1 hour to allow any airborne dust to settle. Do not enter work area during that hour.
    - c. Conduct visual examination
      - 1) Determine if all required work has been completed and all lead-based paint hazards have been controlled.
      - 2) Determine if there is visible settled dust, paint chips, or debris in the interior or around the exterior.
    - d. Complete the Visual Clearance Form required by the the Owner; if all work is not completed inform the the Owner and order completion of the work and repeat cleanup, if necessary.
    - e. Conduct clearance dust sampling of the floors, interior window sills, and window troughs using approved protocol.
    - f. Conduct soil sampling if bare soil is present that was not sampled previously, or if exterior paint work was completed as part of the lead hazard control effort. Whenever exterior work has been don, it may be necessary to take samples from the soil that is not bare to determine if contamination has occurred. If results are above 1,000 µg/g (or 400 µg/g in high contact play area), compare the results to baseline soil sampling results to determine what additional measures are needed.
    - g. Complete the Dust and Soil Sampling Clearance Form required by the the Owner.



- h. Submit samples to a U.S. Environmental Protection Agency (EPA) recognized laboratory participating in the National Lead Laboratory Accreditation program (NLLAP) for analysis.
- i. Interpret results by comparing them to Interim Clearance Standards as listed below:
  - 1) Floors 400 µg/ft<sup>2</sup>
  - 2) Window sills 250 µg/ft<sup>2</sup>
  - 3) Window Troughs 800 µg/ft<sup>2</sup>
  - 4) Soils (Play area with children under 6 years of age) 400 µg/gram
- j. If clearance is achieved go to step N.
- k. Order repeated cleanings or soil treatments if results are above applicable standards. Clean all surfaces the sample represents.
- l. Continue sampling and repeated cleanings until the dwelling achieves compliance with all applicable clearance standards.
- m. Complete any related construction work that does not disturb a surface with lead-based paint (all work that does disturb painted surfaces or that could generate lead dust should be completed as part of the lead hazard control effort).
- n. Issue any necessary statements of lead-based paint compliance or releases and maintain appropriate records.

J. Labels

- 1. Use the following labels on drums used for disposal.

**HAZARDOUS  
WASTE**

FEDERAL LAW PROHIBITS IMPROPER DISPOSAL.  
IF FOUND, CONTACT THE NEAREST POLICE OR PUBLIC SAFETY  
AUTHORITY OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY.

GENERATOR INFORMATION:

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_ PHONE \_\_\_\_\_

CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_

EPA- / MANIFEST  
ID NO. / DOCUMENT NO. \_\_\_\_\_ / \_\_\_\_\_

ACCUMULATION START DATE \_\_\_\_\_ EPA WASTE NO. \_\_\_\_\_

**HAZARDOUS WASTE, SOLID, N.O.S.**

( \_\_\_\_\_ )

**NA3077**

D.O.T. PROPER SHIPPING NAME AND UN OR NA NO. WITH PREFIX

**HANDLE WITH CARE!**

STYLE HMM12



<b>WORKPLACE ACCUMULATION CONTAINER</b>		
Proper D.O.T. Shipping Name: _____	<b>HAZARDOUS WASTE</b>	Workplace Accumulation Start Date: <input type="text"/>
UN or NA# _____		
Generator Information:	<b>FEDERAL LAW PROHIBITS IMPROPER DISPOSAL. IF FOUND, CONTACT THE NEAREST POLICE OR PUBLIC SAFETY AUTHORITY OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY. HANDLE WITH CARE!</b>	Waste Accumulation Area: <input type="text"/>
Name: _____		
Facility: _____		
Address: _____		
Phone: _____		
City: _____		
State: _____ Zip: _____		
EPA / Manifest ID No. / Document No. _____		
State Manifest Document No. _____		
EPA Waste No. _____		<b>MANEJESE CON CUIDADO CONTIENE DESPERDICIOS TOXICOS</b>



## K. Disposal of lead-based paint waste.

1. Follow the RCRA and HUD recommended practices as defined in the table below:

<b>Waste Management Practices</b>	<b>Category I: Low Lead Waste</b>	<b>Category II: Architectural Components</b>	<b>Category III: Concentrated Lead Waste</b>	<b>Category IV: Other waste</b>
<b>RCRA Requirements</b>	Manage as nonhazardous Waste	Depending upon knowledge or TCLP testing results, manage as solid hazardous or nonhazardous waste	If more than 100 kg/ month, manage as hazardous waste. If less than 100 kg/month manage as solid waste.	Use TCP to determine if waste is hazardous.
<b>HUD Recommended Practices</b>	Applicable	Applicable, if knowledge or TCLP testing indicates that it is nonhazardous.	Applicable if less than 100 kg/month otherwise subject to full RCRA regulations	Only applicable if TCLP testing shows waste is nonhazardous
Wrapped in plastic; seal all seams with tape (if acceptable to the disposal facility).	X	X	X	X
Stored in designated, secure area.	X	X	X	X
Covered During Transport	X	X	X	X
Prohibit cutting/breaking outside work area.	X	X	X	X
Cover ground with 6-mil plastic if handling outside.	X	X	X	X
Prohibit disposal in solid waste incinerators and reuse recycling for mulch	X	X	X	X
Recommended disposal in State licensed/permitted	X	X	If appropriate.	X



solid waste landfill.				
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L. Safety Requirements

1. To protect the health and safety of all persons involved, it is of the utmost importance that deleading is safely and correctly done in a timely manner. The following specific safety requirements are the responsibility of the Deleading Contractor.

K. General Safety:

1. General
  - a. NO ONE is to be allowed in the work area without an approved respirator except for methods that have been documented not requiring a respirator.
  - b. Each work area must be sealed from the remainder of the dwelling by taping plastic sheets (6 mil thick). Work areas must remain sealed off until both work and clean-up are completed.
  - c. Cover all floors, carpets, furniture and appliances with 6 mil plastic within the work area. Use automotive masking tape (2 inches wide) to seal all edges and seams.
  - d. Make certain all electrical connections are properly grounded.
  - e. At least three days prior to the start of any deleading work, post appropriate warning signs at all entrances and exits of work areas and leave in place until all clearance testing indicates that these areas are safe for re-occupancy. The signs must include the following phrase: "CAUTION LEAD HAZARD-KEEP OUT". Post bilingual signs when necessary.
2. Worker Safety: The Deleading Contractor shall take the following minimum precautions to protect the health of all individuals involved in the deleading process.
  - a. Pre-Abatement Medical Exam: Each employee shall undergo a medical examination to determine both respiratory fitness capability and also pre-existing/current blood lead level. Said results shall be provided to the employee and also to the Owner within 3 days of receipt of same, and in all cases, prior to employee's commencement to active abatement. Records of same are required to be kept by the Contractor for 40 years.
  - b. Medical Surveillance is the monitoring of worker blood levels. It is required that the Contractor have blood level monitoring of all active abatement and clean-up workmen and on-site supervisors performed and said results provided to the Owner.
    - 1) Before assignment to active abatement activity for each worker.
    - 2) 30 days after active abatement has begun.
    - 3) At least every two months during the first six months and every six months throughout the deleading job.
    - 4) At least every two months for each employee whose blood lead analysis indicated a blood lead level at or above 25 micrograms per deciliter. (20 micrograms per deciliter for women of child bearing age).
    - 5) At termination of employment.
    - 6) Contractor shall reassign any employee whose blood lead has reached 25 µg/dl (20 µg/dl for women of child bearing age) to a job function deemed safe from lead exposure. Said employee shall remain away from active abatement until such time as 2 consecutive months' blood tests indicate µg/dl below 20 µg/dl.
  - c. Respiratory Protection Programs must be established by the Contractor in accordance with OSHA regulations and qualitative respirator fit testing must be conducted daily by the on-site supervisor. Medical examinations must be performed by a physician prior to fit testing and at anytime when a worker demonstrates any difficulty breathing during the use of or the fit testing of respirators. The following are minimal acceptable respiratory protection program requirements as set up and administered by the Contractor:
    - 1) Written standard operating procedures which oversees the selection and use of respirators.
    - 2) Selection of respirators on the basis of hazards to which the worker is exposed.
    - 3) Worker training on the limitations and use of respirators (includes fit testing).
    - 4) Individual workers assigned respirators for their exclusive use only.



- 5) Daily cleaning and disinfecting of respirators.
- 6) Proper storage of all respirators.
- 7) Proper inspection of all respirators for wear and tear.
- 8) Continual surveillance of work area conditions and level of worker exposure or stress.
- 9) Use of approved respirators only, modified as needed by the weekly exposure monitoring results.
- 10) Supply weekly report covering items 1-9 to the Owner or its Lead Consultant.
- d. Exposure Monitoring is the measured concentration of lead in the workers breathing zones. The Contractor shall perform personnel monitoring during active abatement using the NIOSH 7072 method and shall be responsible for:
  - 1) Monitoring the level of worker protection needed during the abatement process;
  - 2) Evaluating, modifying and improving any engineering and work practice control(s) as needed;
  - 3) Evaluating each employee's personal quality of work and any need for additional worker training or safety instruction;
  - 4) Providing the Owner results of all personnel monitoring tests within 10 days of testing; and
  - 5) Providing half-face APR respirators with HEPA filters unless said monitoring test results dictate differently. OSHA guidelines shall be used to determine respirator PEL protection factors.
- e. Protective Clothing Equipment must be provided to all workers to help assure that lead dust is contained to the work areas. The following must be supplied/enforced by the Deleading Contractor:
  - 1) Full body protective clothing and shoe covers of appropriate sizes on a daily basis or as needed.
  - 2) Clean changing areas separated from the dirty/contaminated clothes storage area.
  - 3) Water and wash facilities for washing of hands and face and shower facilities if deemed necessary by the Owner's Lead Advisor.
  - 4) Instructing worker on proper maintenance of clothing and equipment.
  - 5) Proper disposal of disposable clothing and proper permanent work clothes.
  - 6) Enforcing the removal of protective clothing at the end of each work day and before eating, drinking and smoking.
  - 7) Enforcement of the removal of protective shoe covers before leaving work area.
3. Contractor/Worker Daily Safe-Work Procedures
  - a. Daily Start-Up:
    - 1) Workers to put on protective gear prior to entering work areas.
    - 2) All garment seams to be sealed with duct tape.
    - 3) All non-working garments must be stored in designated changing area.
    - 4) Respirators, as required, must be properly fitted before entering work area. Perform qualitative fit test.
  - b. Temporary depart:
    - 1) All protective clothing to be HEPA vacuumed while still being worn.
    - 2) All shoe covers to be removed and left in the work area (immediate departure upon removing).
    - 3) Remove all protective gear in designated "contaminated" changing area before eating, drinking, and smoking or before leaving work site.
    - 4) Wash hands and face.
    - 5) Clean respirators.
  - c. Daily Shut-Down:
    - 1) Dispose of protective clothing with abatement waste by sealing in a 6 mil poly bag.
    - 2) Laundered clothes must be placed in closed container.
    - 3) Wash hands and face.
    - 4) Shower if facilities allow and circumstances dictate.
    - 5) Clean all protective gear (respirators included).



4. Tenant's Safety: Temporary relocation of the tenants is necessary if the lead paint surface is broken. Temporary relocation of the tenants and their belongings is the responsibility of the Owner. However, the Contractor has the joint responsibility to administer and enforce the following safety practices on behalf of the occupants:
  - a. Adults
    - 1) NO OCCUPANT is allowed to enter the work area during paint removal and initial clean-up. A three day clean-up and settlement period may be imposed depending upon the abatement procedures used, at the discretion of the Owner or their Lead Consultant.
    - 2) the Owner shall notify all occupants in writing when they are allowed to return to their post-abated residence. Contractor shall abide by these notices.
    - 3) Every resident who has received prior notice of abatement is responsible for placing all personal items (clothing, dishes, linens, etc.) in closed, easy to handle containers; and move such items to the center of each room as requested.
    - 4) As long as visible dust remains, occupants may not occupy dwelling, and all surfaces within the dwelling must be re-washed with trisodium phosphate and HEPA vacuumed by deleading contractor.
    - 5) Persons reoccupying dwellings following abatement are required to report any visible dust or debris to the Owner immediately for additional Contractor clean-up.
  - b. Pregnant Women and Children
    - 1) Absolutely no pregnant women nor children under the age of twelve years of age may be allowed in the building while any part of the abatement process is going on.

END OF SECTION 02 83 19 13a



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**SECTION 02 83 19 13b - XRF TESTING FOR LEAD-BASED PAINT****1.1 DESCRIPTION OF WORK**

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

**1.2 SUMMARY**

- A. The Contractor shall perform work in accordance with the latest HUD Guidelines, in accordance with all applicable regulations of the Environmental Protection Agency (EPA), Occupational Safety & Health Agency (OSHA) and any applicable State or Local standards that may be more stringent than the Federal Standards except, as such guidelines are modified by the Owner in writing in this contract or any contract pursuant to this contract.
- B. Workmanship required in the execution of the work herein specified shall be of good quality and subject to the approval of the the Owner.

**1.3 SUBMITTALS**

- A. Notification Before Start of Work
  1. The Contractor shall send notices to the Project Superintendent, Residents, and the Department of Planning and Development 48 hours before the scheduled start of work. The Contractor shall make three (3) attempts to gain entry to each apartment, with proper 48 hour notification to the resident each time.
  2. The Contractor shall begin work no later than 48 hours after receiving a work proceed order.
- B. Copies of the submissions listed below must be tendered with the bid:
  1. Ability to perform XRF testing and paint chip sampling by submitting evidence of the successful completion of lead inspector training by all staff to be assigned to the job including inspector technicians. Training must be provided through a State approved EPA-Model program. All staff assigned to the Contract must also demonstrate training in the use of the XRF testing machines to be dedicated to this contract. The serial number of such XRF machine shall be provided to the Owner.
    - a. Contractor or Subcontractor performing the work must have at least 3 years of satisfactory experience (documented) in performing XRF testing for a City, State or Federal Agency.
  2. Laboratory certification by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
  3. If a subcontractor will be used for any of the laboratory work of this contract, evidence of certification stated above must also be provided for the subcontractor.

**C. XRF Testing Report Format**



- a. All XRF report must be made after a formal submittal and approval by the Owner.
- b. A faxed summary report must be provided to the the Owner within 48 hours after completion of testing for a work Authorization. For XRF testing requiring confirmation by laboratory analysis of paint chip samples, the faxed summary report must be provided within 48 hours after the the Owner gives approval for testing of the collected paint chip samples.
- c. A detailed report must be provided to the the Owner within 5 business days after completion of the testing.

#### 1.4 QUALITY ASSURANCE

- A. The work shall consist of furnishing all labor, material, insurance and all other incidental items required to do the following:
  1. XRF Testing
    - a. Random or comprehensive testing of various components in single family housing units, multi-family housing units, common areas and exterior sites, using any of the approved X-ray Fluorescence ("XRF") machines, to determine if the lead-based paint concentration is within permissible limits.  
Note: Testing may be for entire apartments or selected rooms or components within the apartment.
    - b. The permissible limit shall be defined as a final reading showing a lead concentration of less than 1.0 mg/cm<sup>2</sup>.
    - c. Refer to the Manufacturer's manual, as well as the "XRF Performance Characteristic Sheet" when determining calibration check tolerance, and other instrument specific information. Use the adjusted "XRF Performance Characteristic Sheets" in this contract when determining the inconclusive range.
    - d. In addition to the manufacturer's recommended warm up and quality control procedures, a set of three nominal XRF calibration check readings must be taken before the inspection begins and after the inspection has been completed in a particular unit, or every 4 hours, whichever occurs first. All reference material values and calibration check readings must be included in the report provided to the Owner.
    - e. Do not use the XRF to test highly curved or ornate surfaces, or surfaces inaccessible to the XRF, due to poor reliability of results. For such surfaces, laboratory analysis of paint chips must be done.
    - f. Only one XRF reading is required per testing combination. A unique testing combination is characterized by the room equivalent, the component, the substrate and the visible color of the paint. However, testing combinations with different colors on the same component and substrate may be combined into a single component type.
    - g. All inconclusive results must be treated according to the inspection rules using multi-family inspection or single family inspection rules as appropriate.
    - h. XRF field data sheets shall be filled out as they appear on completed Form 7.1("Single-Family Housing LBP Testing Data Sheet") and 7.5 ("Multifamily Housing LBP Testing Data Sheet") in HUD Guidelines.
    - i. Room equivalents or sections thereof that are not accessible for testing (i.e. locked bedrooms) shall be noted in the final report to the Owner.
  2. Laboratory testing of paint chips.
    - a. Collection of paint chips from various painted components for laboratory analysis due to XRF substrate corrected inconclusive and/or positive readings as directed by the the Owner.



- b. Laboratory preparation and testing by Flame Atomic Absorption Spectrometry (FAAS) or Graphite Furnace Atomic Absorption Spectrometry (GFAAS) to determine if the lead paint concentration is within permissible limits.
  - c. The permissible limit shall be defined as a lead concentration less than 0.5% by weight.
  - d. Collect paint chips in accordance with ASTM ES28-94.
  - e. Prepare paint chips in the laboratory for testing in accordance with ASTM ES37-94.
  - f. Repair and repaint areas from which paint chips have been collected, to match adjacent areas, unless notified by the the Owner in writing to utilize a temporary covering for the tested surfaces. The Contractor shall provide water based latex paint for this purpose. Colors shall be limited to white and off-white; and other colors if provided by the tenant.
  - g. Only one paint chip is required per testing combination. A unique testing combination is characterized by the room equivalent, the component, the substrate, and the visible color of the paint. However, testing combinations with different colors on the same component and substrate may be combined into a single component type.
  - h. Field data sheets and signed chain of custodies must be attached to the final report to the Owner.
- B. Occupied Residences
1. Some of the work of this contract will be in occupied apartments. The Contractor shall perform all of the work of this contract with the least inconvenience to the tenants.
  2. The Contractor shall take all necessary precautions to protect the property of the the Owner, its residents and the public. The contractor must repair any damaged property, whether of the the Owner, its residents, or the public, and restore such property to its original condition. If the damage is beyond repair, the Contractor shall replace it with new, that in the judgement of the the Owner, match the existing materials and are of equal quality and workmanship. All such repairs shall be at the Contractor's expense.
- C. Applicable Regulations
1. ASTM Standards
    - a. ASTM E 1583 on evaluating laboratories used to determine lead levels;
    - b. ASTM E 1605 on terminology;
    - c. ASTM E 1613 on determining lead by atomic emission or atomic absorption spectroscopy;
    - d. ASTM E 1645 on laboratory preparation of paint-chip samples;
    - e. ASTM E 1775 on-site extraction and field portable stripping voltammetry analysis for lead;
    - f. ASTM PS 53 on identifying and managing lead in facilities;
    - g. ASTM PS 87 on ultrasonic extraction for later analysis for lead;
    - h. ASTM PS 88 on determining lead by portable electro analysis
  2. OSHA Standards (without limitation), include:
    - a. 29 CFR 1926.20 - General safety and health provisions;
    - b. 29 CFR 1926.21 - Safety training and education;
    - c. 29 CFR 1925.25 - Housekeeping;
    - d. 29 CFR 1926.28 - Personal protective equipment;
    - e. 29 CFR 1926.51(f) - Washing facilities;
    - f. 29 CFR 1926.55 - Gases, vapors, fumes, dusts, and mists;
    - g. 29 CFR 1926.57 - Ventilations;
    - h. 29 CFR 1926.59 - Hazardous Communication Standards;
    - i. 29 CFR 1926.10 - Respiratory protection; and
    - j. 29 CFR 1926.62 - Lead in Construction
  3. The Contractor must comply with all applicable requirements of the Resource Conservation & Recovery Act (RCRA) of 1976 as amended in 1980 and 1984 by the Hazardous & Solid Waste Amendments (HSWA).



4. The Contractor must follow the XRF Performance Characteristic Sheet (PCS) for all inspection activities. XRF PCSs are available from the National Lead Information Center Clearinghouse or through the HUD website at <http://www.hud.gov/offices/lead/lbp/hudguidelines/allpcs.pdf>.

## 1.5 PRODUCTS

### A. XRF Instruments and Testing Protocols

1. The Contractor shall use XRF instruments that are approved by the Owner.
2. XRFs must be used in accordance with the manufacturer's instructions and the XRF Performance Characteristic Sheet. If discrepancies exist between the XRF Performance Characteristic Sheet, the HUD Guidelines and the manufacturer's instructions, the most stringent guidelines should be followed.

## 1.6 EXECUTION

### A. Inspection and Testing

#### 1. Single Family Testing Rules

- a. If the housing development has less
  - 1) than 10 units built between 1960-1970 or
  - 2) 20 units built before 1960 or
  - 3) the random testing rules in a multi-family development are not being used then single family testing rules must be followed.
- b. List all testing combinations (see HUD Guidelines Table for an example) in all interior rooms, on all exterior building surfaces, and on surfaces in other exterior areas, such as fences, playground equipment, and garages. The "SingleFamily Housing LBP Testing Data Sheet" (see HUD Guidelines) or a comparable data collection instrument may be used for this purpose.
  - 1) Test all room equivalents inside and outside the dwelling unit. The final report must include a final determination of the presence or absence of lead-based paint on each testing combination in each room equivalent.
  - 2) Inspect each testing combination in each room equivalent, unless similar building component types with identical substrates (such as windows) are all found to contain lead-based paint in the first five interior room equivalents. In that case, testing of that component type in the remaining room equivalents may be discontinued, if and only if the Owner agrees beforehand to such a discontinuation. The inspector should then conclude that similar building component types in the rest of the dwelling unit also contain lead-based paint.
  - 3) Painted furniture that is physically attached to the unit (for example, a desk or dresser that is built-in) should be included in the inspection as a testing combination.
  - 4) Results of an inspection may be summarized by classifying component types across room equivalents if patterns or trends are supported by the data.
  - 5) All substrates across all room equivalents should be grouped into one of the six substrate categories (brick, concrete, drywall, metal, plaster, or wood).
- c. Number and Location of XRF Readings
  - 1) XRF testing is required for at least one location per layers of paint should be included and the XRF probe testing combination, except for interior and exterior faceplate should be able to lie flat against the surface walls, where four readings should be taken, one on of the test location each wall.
  - 2) For interior and exterior walls: take at least four readings (one of ea. wall). If there are more than four walls test the four largest walls, calculate the average of the



- readings, round the result to same number of decimal places as the XRF instrument displays, and classify the remaining walls with the same painting history as the tested walls, based on this rounded average. When the remaining walls in a room equivalent clearly do not have the same painting history as that of the tested walls, test and classify the remaining walls individually.
- 3) Select areas of paint which are most likely to have old paint or coatings, where areas of paint appear thickest. Avoid testing where paint has worn away, chipped; or over pipes, electrical surfaces, nails, and any other possible interferences.
  - 4) A numbering system, floor plan, sketch or other system may be used to document which testing combinations were tested and sufficiently detailed enough for another individual to find them.
    - a) Side identification Identify perimeter wall sides with letters A, B, C, and D (or numbers or Roman numerals). Side A for single-family housing is the street side for the address. Side A in multi-family housing is the apartment entry door side. Side B, C, and D are identified clockwise from Side A as one faces the dwelling; thus Wall B is to the left, Wall C is across from Side A, and Side D is to the right of Side A. Each room equivalent's side identification follows the scheme for the whole housing unit. Because a room can have two or more entries, sides should not be allocated based on the entry point. For example, giving a closet a side allocation based on how the room is entered would make it difficult for another person to make an easy identification, especially if the room had two closets and two entryways.
    - b) Room Equivalent Identification Room equivalents should be identified by both a number and a use pattern (for example, Room 5-Kitchen). Room 1 can always be the first room, at the A-D junction at the entryway, or it can be the exterior. Rooms are consecutively numbered clockwise. If multiple closets exist, they are given the side allocation: for example, Room 3, Side C Closet. The exterior is always assigned a separate room equivalent identifier.
    - c) Sides in a Room Sides in an interior room equivalent follow the overall housing unit side allocation. Therefore, when standing in any four-sided room facing Side C, the room's Side A will always be to the rear, Side B will be to the left, and Side D will be to the right.
    - d) Building Component Identification Individual building components are first identified by their room number and side allocation (for example, the radiator in Room 1, Side B is easily identified). If multiple similar component types are in a room (for example, three windows), they are differentiated from each other by side allocation. If multiple components are on the same wall side, they are differentiated by being numbered left to right when facing the components. For example, three windows on Wall D are identified as windows D1, D2, and D3, left to right. If window D3 has the only old original sash, it is considered a separate testing combination from the other two windows. Codes or abbreviations for building components and/or locations may be used in order to shorten the time needed for data entry. If codes or abbreviations are used, the inspection records and the inspection report must include a table showing their meaning.
  - d. XRF Instrument Reading Time
    - 1) The recommended time to open an XRF instrument's shutter to obtain a single XRF result for a testing location depends on the specific XRF instrument model and the mode in which the instrument is operating. Follow manufacturer's instructions per HUD Guidelines.
  - e. XRF Calibration Check Readings
    - 1) Follow manufacturer's instructions per HUD Guidelines.



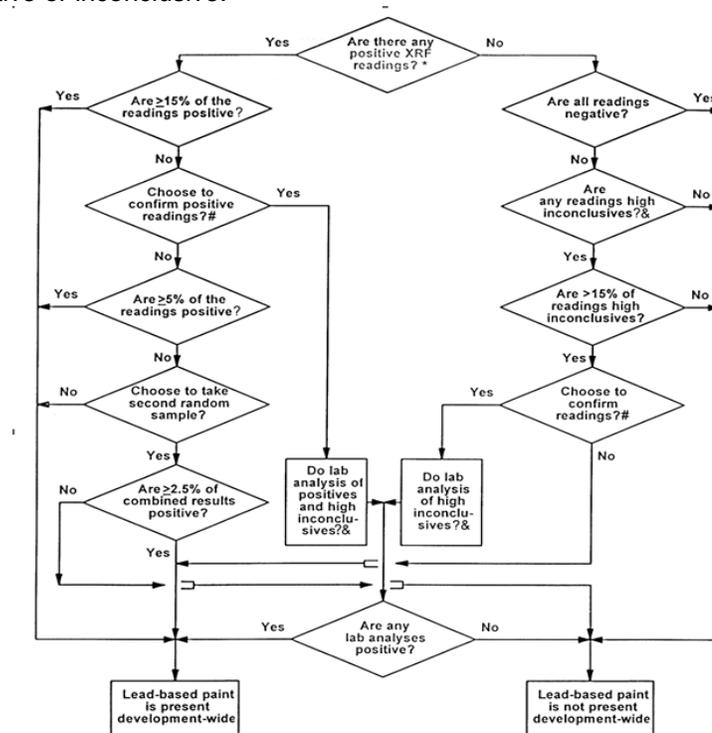
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f. Substrate Correction

- 1) The XRF measurements, corrected for substrate contribution, if required by the Performance Characteristic Sheet ("PCS") for the particular type of instrument being used, should be sorted by the inspector by component type into the following categories:
  - a) Positive- A positive XRF reading in accordance with the XRF's Performance Characteristic Sheet.
  - b) Negative- A negative XRF reading in accordance with the XRF's Performance Characteristic Sheet.
  - c) High Inconclusive- An inconclusive XRF reading equal to or greater than the midpoint of the XRF's inconclusive range, in accordance with the XRF's Performance Characteristic Sheet.



- g. The following Decision analyses will be used to determine which components are positive, negative or inconclusive:



\* "Positive," "negative," and "inconclusive" XRF readings are determined in accordance with the XRF instrument's Performance Characteristics Sheet as described in the HUD Guidelines for the Evaluation and Control of Lead Hazards in Housing, chapter 7.  
 & A high inconclusive reading is an XRF reading at or above the midpoint of the inconclusive range. For example, if the inconclusive range is 0.41 to 1.39, its midpoint (average) is 0.90; a reading in the range from 0.90 to 1.39 would be a high inconclusive reading.  
 # Any paint or coating may be assumed to be lead-based paint, even without XRF or laboratory analysis. Similarly, any XRF reading may be confirmed by laboratory analysis.

- 1)
- 2) All inconclusive results must be confirmed with laboratory analysis, or as an alternative must be classified as positive. the Owner may also wish to confirm positive XRF results with laboratory analysis. Therefore the Contractor must make a field determination of which XRF readings falls in the inconclusive or positive ranges and take paint chip samples during the XRF testing for possible laboratory analysis. If the majority of XRF readings are positive in the first few units, the inspector must consult with the Owner on whether to continue taking paint chip samples. Only the Owner may determine whether to submit collected paint chip samples for laboratory analysis or to classify the element as positive.

**2. Multi-family Housing Testing Rules (Random Sampling)**

- a. In order to use the Multi-family housing testing rules, there must multi-family housing is defined as any group of more than four units that are similar in construction from unit to unit
- b. Determine the number of randomly selected units to be tested in accordance with Table 7.3, below. Chapter 7 of the HUD Guidelines also describes how to select the units randomly. If a unit or units which were selected as part of the original random sample cannot be entered for a particular reason, a replacement unit(s) must be randomly selected in accordance with the HUD Guidelines.



**Table 7.3 Number of Units to be Tested in Multi-family Building or Developments\***

Number of Similar Units, Similar Common Areas, or Similar Exterior Sites	Pre-1960 or Unknown-Age Building or Development: Number of Units to Test *	1960-1977 Building or Development: Number of Units to Test *
1-10	All	All
11-13	All	10
14	All	11
15	All	12
16-17	All	13
18	All	14
19	All	15
20	All	16
21-26	20	16
27	21	17
28	22	18
29	23	18
30	23	19
31	24	19
32	25	19
33-34	26	19
35	27	19
36	28	19
37	29	19
38-39	30	20
40-48	31	21
49-50	31	22
51	32	22
52-53	33	22
54	34	22
55-56	35	22
57-58	36	22
59	37	23
60-69	38	23
70-73	38	24
74-75	39	24
76-77	40	24



Number of Similar Units, Similar Common Areas, or Similar Exterior Sites	Pre-1960 or Unknown-Age Building or Development: Number of Units to Test *	1960-1977 Building or Development: Number of Units to Test *
78-79	41	24
80-88	42	24
89-95	42	25
96-97	43	25
98-99	44	25
100-109	45	25
110-117	45	26
118-119	46	26
120-138	47	26
139-157	48	26
158-159	49	26
160-177	49	27
178-197	50	27
198-218	51	27
219-258	52	27
259-279	53	27
280-299	53	28
300-379	54	28
380-499	55	28
500-776	56	28
777-939	57	28
940-1004	57	29
1005-1022	58	29
1023-1032	59	29
1033-1039	59	30
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2000	116	58
2500	145	73
3000	174	87
3500	203	102
4000	232	116

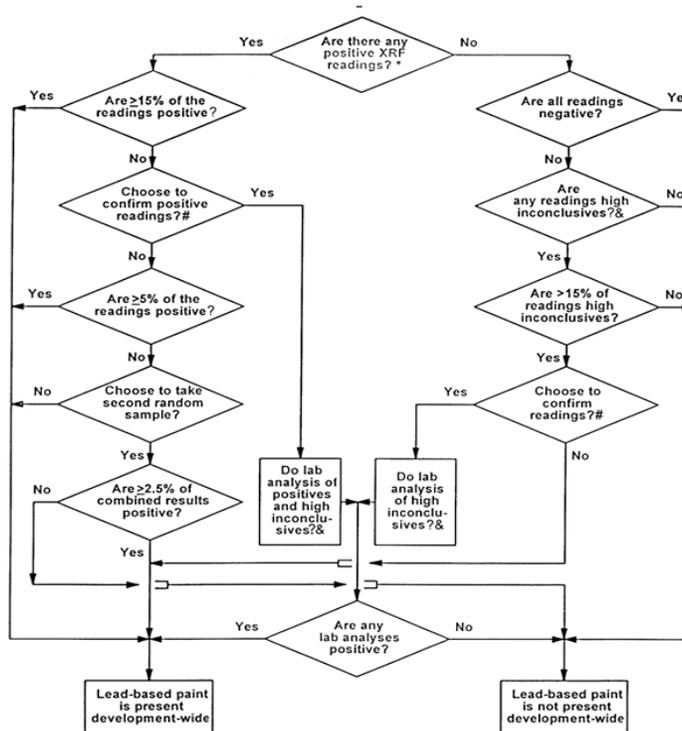
\* For brevity, "Number of Units" and "Number of Units to Test" are used, but the number to test is the same for similar units, similar common areas, and similar exterior sites.



- c. An assessment on each tested component must note four attributes, also called a testing combination.
  - 1) The room equivalent (where the testing took place i.e. bedroom, bathroom, etc.)
  - 2) The component type (door, wall #1 - upper left, etc.)
  - 3) The substrate (brick, wood, concrete, drywall, plaster or metal).
  - 4) The color of the paint.
- d. These attributes must be included as part of the report.
- e. For each testing combination, the condition of the painted surfaces should be noted as either intact, fair or poor.
- f. One reading with the X-ray fluorescence (XRF) instrument on each testing combination is all that is required.
- g. At least 40 components of a given type must be tested to obtain the desired level of confidence in the results throughout the multi-family development. If less than 40 components of a given type exist in the buildings to be tested i.e. they are unique components, then the measurement should be taken using single family testing rules (described below). If less than 40 components of a given type exist in the units to be tested, additional components of this type can be identified in other units in the complex and tested to bring the total up to 40 so that multi-family testing rules can be used. The decision of which option the Contractor should use will be made by the the Owner.
- h. To increase the number of tested components of a given type, testing combinations with different colors on the same component and substrate may be combined into a single component type. For example, if "wood doors" is the component type, all wood doors tested for lead-based paint could belong to the same component type, regardless of color.
- i. A component type may be differentiated by color as long as there are 40 tested and there is a good reason for differentiation.
- j. The XRF measurements, corrected for substrate contribution, if required by the Performance Characteristic Sheet ("PCS") for the particular type of instrument being used, should be sorted by the inspector by component type into the following categories:
  - 1) Positive- A positive XRF reading in accordance with the XRF's Performance Characteristic Sheet.
  - 2) Negative- A negative XRF reading in accordance with the XRF's Performance Characteristic Sheet.
  - 3) High Inconclusive- An inconclusive XRF reading equal to or greater than the midpoint of the XRF's inconclusive range, in accordance with the XRF's Performance Characteristic Sheet.



- k. The following Decision analyses will be used to determine which components are positive, negative or inconclusive:



\* "Positive," "negative," and "inconclusive" XRF readings are determined in accordance with the XRF instrument's Performance Characteristics Sheet as described in the HUD Guidelines for the Evaluation and Control of Lead Hazards in Housing, chapter 7.  
& A high inconclusive reading is an XRF reading at or above the midpoint of the inconclusive range. For example, if the inconclusive range is 0.41 to 1.39, its midpoint (average) is 0.90; a reading in the range from 0.90 to 1.39 would be a high inconclusive reading.  
# Any paint or coating may be assumed to be lead-based paint, even without XRF or laboratory analysis. Similarly, any XRF reading may be confirmed by laboratory analysis.

- l. If there are readings on a component type(s) equal to or greater than 1.0 mg/cm<sup>2</sup> and paint chip samples are submitted to the laboratory, there are two possible results:
  - 1) If all lab samples on a component type are below 0.5% lead by weight, the component type can be classified as negative throughout the development.
  - 2) If one or more lab results are positive, (equal to or greater than 0.5% lead by weight for a component) the the Owner will take one of three options:
    - a) Treat the component type as positive throughout the development, or
    - b) Test the component type throughout the development, or
    - c) If 5% or less of the component type are positive, take a second random sample, just testing that component type.
  - 3) If option 2)c) above is selected by the Owner and the combined results of the first and second random sample are less than 2½% positive, the following additional options are available depending on the results.
    - a) If no positives are found in the second sample, no further testing is necessary. Those positives in the first random sample will be monitored/abated (not by this Agreement), but the rest of the component type can be classified as negative.



- b) If positives are found on a component type in the second sample, the the Owner has the option to classify the component type as positive throughout the development or comprehensively test it.
  - c) If the combined results of the two random samples are equal to or greater than 2½%, the the Owner also has the option to comprehensively test the remaining components of that type or classify them as positive.
- m. **Paint Chip Sample Size:** The Paint chip samples should be taken from a 4 square inch (25 square centimeter) area that is representative of the paint on the testing combination, as close as possible to any XRF reading locations and, if possible, unobtrusive. This area may be a 2" x 2" (5 x 5 centimeters) square, or a 1" x 4" (2.5 x 10 centimeters) rectangle, or have any other dimensions that equal at least 4 square inches (25 square centimeters). Regardless of shape, the dimensions of the surface area must be accurately measured (to the nearest millimeter or 1/16<sup>th</sup> of an inch) so that the laboratory results can be reported in mg/cm<sup>2</sup>. Results should be reported as percent by weight if the surface area cannot be measured accurately or if all paint within the sampled area cannot be removed. In these cases, lead should be reported in ppm or percent weight, not in mg/cm<sup>2</sup>. Smaller surface area can be used if acceptable to the laboratory. (See ASTM E 1729). In all cases those who take the samples should consult with the NLAAP recognized laboratory selected regarding the requirements for the submission samples for lead-based paint analysis.
- n. If the the Owner decides to test in search of these hard-to-find components coated with lead based paint, the inspector must use the single family testing rules described in the previous section.
- 3. Common Areas and Exterior Sites Testing Rules**
- a. Similar common areas and similar exterior sites must always be tested, but in some cases they can be sampled in much the same way that dwelling units are. Common areas and building exteriors typically have a similar painting history from one building to the next. In multifamily housing, each common area (such as building lobby, laundry room, or hallway) can be treated as a dwelling unit. If there are multiple similar common areas, they may be grouped for sampling purposes I exactly the same way as regular dwelling units. However, dwelling units, common areas and exterior sites cannot be all mixed together in a single group. All testing combinations within each common area or building exteriors selected for testing must be inspected. This includes playground equipment, benches and miscellaneous testing combinations located throughout the development. The specific common areas and building exteriors to test should be randomly selected, in much the same way as specific units are selected using random numbers. The number of common areas to be tested should be taken from table 7.3 (HUD Guidelines). In this instance, common areas and building exteriors can be treated in the same way as housing units (although they are not to be confused with true housing units).
- 4. Unit and Common Area Drawings**
- a. Mark-ups of as built drawings depicting room equivalents that are tested must be provided as part of the report.
  - b. The Contractor should test in a clockwise path starting from the door through the space and room equivalents so that the approximate location of each component tested can be easily established by referencing the room equivalent and sides.
  - c. Each space must have a reference point (side A, B, C, D or wall 1, 2, 3 or 4). The wall with the door should always be referenced as wall 1 or side A. If there is more than one door, wall 1 or side A should be used to refer to the wall with the door through which the room is first entered when moving in a clockwise fashion through the unit.

**B. Evaluation of the Inspection by the the Owner**



1. The Contractor will be required to carry out retesting at no additional cost to the the Owner, after completion of the Inspection at each the Owner's development as described in the HUD Guidelines, for single family housing, multi-family housing and common areas. The the Owner shall randomly select the testing combinations to be retested and the Contractor shall perform the retesting using the same XRF instrument(s) which was/were used to take the original readings. An the Owner's inspector shall be present to observe all retesting. The retesting shall be limited to ten (10) testing combinations, and if necessary to repeat the retest, the testing combinations randomly selected for repeating the retest shall also be limited to ten.
  2. If the retest tolerance limit computed from the information provided in the "XRF Performance Characteristics Sheet" (see HUD Guidelines) is exceeded, the retest will be repeated as described in the HUD Guidelines for single family, multi-family housing and common areas. If the retest tolerance limit is exceeded again, the the Owner may require the Contractor to retest the entire development at no additional cost to the the Owner, or the the Owner may withhold all payments and terminate its agreement with the Contractor.
- C. Option to do Laboratory Testing only
1. The the Owner may, for a specific testing assignment, request in writing that the Contractor, when utilizing the multi-family housing testing rules for random sampling, or the single family housing testing rules, do all testing through laboratory analysis of paint chips rather than through XRF Spectrum Analyzer testing with laboratory confirmation as needed. Please note that under the single family housing testing rules, only one paint chip must be taken and analyzed for each component type.
- D. Waste Disposal
1. All waste generated must be legally disposed in accordance with Federal, State and Local regulations.

END OF SECTION 02 83 19 13b



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**SECTION 02 83 19 13c - LEAD DUST WIPE, AIR AND TCLP SAMPLING AND ANALYSIS****1.1 DESCRIPTION OF WORK**

- A. This specification covers the furnishing and installation of materials for lead dust wipe, air and TCLP sampling and analysis. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**1.2 GENERAL**

- A. Definitions: Unless otherwise specified the following definitions shall apply:
1. **"Approved"**: shall mean approved by all public agencies having jurisdiction, and the Owner.
  2. **"The Owner"**: shall mean the Owner and its designated authorized representatives.
  3. **"Contractor"**: shall mean the firm that is awarded this contract and is responsible to ensure compliance with Federal, State and City regulations as well as these Contract documents.
  4. **"Development or Project"**: a group of buildings in one or more designated geographical locations, owned or operated by the Owner and referred to by a common name by the Owner.
  5. **"Dust Cleaning Firm"**: shall mean the contractor under a separate contract or the Owner responsible for cleaning of lead dust, as directed by the Owner, until the clearance levels are achieved, as defined in the "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, June 1995" or latest edition published by the United States Department of Housing and Urban Development (HUD).
  6. **"Equal or Approved Equal"**: shall mean equal in the opinion of the Owner.
  7. **"HUD"**: the United States Department of Housing and Urban Development.
  8. **"HUD Guidelines"**: shall mean Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing issued by HUD'S Office of Lead-Based Paint Abatement and Poisoning Prevention in June 1995 except as such guidelines are later modified by HUD and/or modified by the Owner in writing pursuant to this contract.
  9. **"Inspector"**: an individual who has completed training from an accredited program and been licensed or certified by the appropriate State or local agency to (1) perform inspections to determine and report the presence of lead-based paint on a surface-by-surface basis through on-site testing, (2) report the findings of such an inspection, (3) collect environmental samples for laboratory analysis, (4) perform clearance testing, and (5) document successful compliance with lead-based paint hazard control requirements or standards.
  10. **"Lead-Based Paint"**: any paint, varnish, shellac, or other coating that contains lead equal to or greater than 1.0 mg/cm<sup>2</sup> as measured by XRF or laboratory analysis, or 0.5 percent by weight (5,000 µg/g, 5,000 PPM, or 5,000 mg/kg) as measured by laboratory analysis.
  11. **"Lead-Based Paint Hazard"**: a condition in which exposure to lead from lead-contaminated dust, lead-contaminated soil or deteriorated lead-based paint would have an adverse effect on human health (as established by the EPA Administrator under Title IV of the Toxic Substance Control Act). Lead-based paint hazards include for example, deteriorated lead-based paint, leaded dust levels above applicable standards and bare leaded soil above applicable standards.
  12. **"Lead-Based Paint Hazard Control"**: activities to control or eliminate lead-based paint hazards, including interim controls and complete abatement.
  13. **"Lead-Contaminated Dust"**: surface dust in residences that contain an area or mass concentration of lead in excess of the standard established by the EPA Administrator, pursuant to Title IV of the Toxic Substance Control Act. Until the EPA standards are set, the HUD recommended clearance and risk assessment standards for leaded dust are 40 µg/ft<sup>2</sup> on floors, 250 µg/ft<sup>2</sup> on interior window sills, and 800 µg/ft<sup>2</sup> on window troughs.



14. **"Monitoring"**: shall refer to inspection to ensure compliance with all Federal, State and City Standards or guidelines, and contractual specifications.
15. **"Provide"**: shall mean furnish and install.
16. **"Risk Assessor"**: a certified individual who has completed training with an accredited training program and who has been certified to (1) perform risk assessments, (2) identify acceptable abatement and interim control strategies for reducing identified lead-based paint hazards, (3) perform clearance testing and reevaluations, and (4) document the successful completion of lead-based paint hazard control activities.

B. Applicable Regulations/References

1. The work conducted shall comply with all applicable Federal, State and City regulations. Applicable guidelines and standards listed in the scope of work include, but are not limited to:
 

24 CFR Parts 35,36,37 Guidelines for the Evaluation and Control of Lead-Based Paint in Housing (HUD Guidelines June 1995) & 1997 Revisions 29 CFR 1910 29 CFR 1910.1025 29 CFR 1910.134 29 CFR 1910.1200 29 CFR 1910.245 29 CFR 1926 29 CFR 1926.20 29 CFR 1926.21 29 CFR 1926.25 29 CFR 1926.28 29 CFR 1926.51 29 CFR 1926.55 29 CFR 1926.59 29 CFR 1926.62 29 CFR 1926.103 40 CFR 61 Subpart A 40 CFR 241  40 CFR 257 40 CFR 261/262 American National Standards Institute (ANSI) Z87.1 ANSI Z88.2-80 American Society For Testing Materials (ASTM)	HUD Lead-Based Paint Regulations  General Industry Standard Lead Standard for General Industry Respiratory Protection Hazard Communication Specification for Accident Prevention Construction Industry Standards General Safety & Health Provisions Safety Training & Education Housekeeping Personal Protective Equipment Washing Facilities Gases, Vapors, Fumes, Dusts & Mists Hazard Communication Standard Construction Industry Lead Standard Respiratory Protection General Provisions Guidelines for the Land Disposal of Solid Waste Criteria for the Land Disposal of Solid Waste Waste Disposal Facilities & Practices Eye Protection  Practices for Respiratory Protection All Applicable Standards
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2. The contractor shall ensure that any programs, certifications, licenses or other documentation in accordance with the above and/or any other applicable Federal, State, and Local Regulations/Guidelines are provided.

C. Scope Of Work

1. The work shall consist of furnishing labor, materials, insurance and all other incidental items required to perform the following:
  - a. Dust wipe sampling and analysis
    - 1) Collect dust wipe samples from various horizontal surfaces, such as floors, window sills, window troughs, etc., as directed by the Owner.
    - 2) Dust wipe samples shall be collected in accordance with ASTM ES30-94.



- 3) Analyze dust wipe sample in the laboratory using Flame Atomic Absorption Spectrometry ("FAAS") or Graphite Furnace Atomic Absorption Spectrometry("GFAAS").
  - 4) Provide result of analysis in micrograms per square foot.
  - 5) A faxed summary of results must be provided to the Owner within 24 hours after the Owner authorizes the Contractor to perform the laboratory analysis of the collected dust wipe sample. Contractor shall also have the ability to provide results in 4 hours for clearance, following lead-based paint abatement work, if requested by the Owner. The sampling result must be provided in a form approved by the Owner and must include for each dust wipe sample, the Project, the building address, the sample number, the room or room equivalent, the surface type, dimensions of sample areas, total micrograms, micrograms per square feet, and an indication of pass or fail.
  - 6) Turn-around time for results shall be counted from the time the Contractor performs collection of dust wipe samples to the time the results are actually presented to the Owner. This includes travel time from the site to the laboratory of the Contractor and back to the site.
  - 7) A detailed final report covering the results of all dust wipe samples taken and analyzed must be submitted within 5 days from the time the Owner authorizes the performance of the laboratory analysis. The sampling report must include for each dust wipe sample, the Project, the building address, the sample number, the room or room equivalent, the surface type, dimensions of sample areas, total micrograms, micrograms per square feet, and indicate pass or fail in a form approved by the Owner. Also include in the report the method of analysis, i.e. "FAAS" or "GFAAS", and the detection limits. The laboratory test results in the final report must be signed by the Laboratory Director.
  - 8) The sampling data report must contain all required data fields as specified by the Owner. The sampling data report shall be provided to the Owner on 3.5 inch high density diskettes in ASCII file form. The required data fields will be provided by the Owner to the Contractor.
  - 9) The laboratory used for the analysis of the dust wipe samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
- b. Dust Spiked Samples
- 1) Provide dust spiked samples to the Owner. Dust spiked samples shall be prepared in accordance with the HUD Guidelines.  
**NOTE:** These samples are separate from the ones required by the Contractor for its own QA/QC
  - 2) Prepare dust spiked samples in a manner such that they are indistinguishable from the field samples.
  - 3) Prepare dust spiked samples using the same lot as that to be used in the field.
  - 4) Dust spiked samples shall be inserted into the sample stream, randomly, by the Owner Inspector.
  - 5) Blind analysis of dust spiked samples must fall within 80%-120% of the true value. If the laboratory fails to obtain readings within these limits, two more spiked samples shall be sent immediately to the lab for analysis.
  - 6) If the two additional spiked samples fail, the sample batch shall be considered invalid, and the Owner may, at its sole discretion, terminate this contract as well as withhold payment for services already rendered.
- c. Air Sampling and Analysis



- 1) Collect area air samples at various locations and various projects for personal exposure assessment as directed by the Owner.
  - 2) Air samples shall be collected in accordance with ASTM E1553-93.
  - 3) Prepare air samples for analysis in accordance with ASTM E33-94
  - 4) Analyze air samples using FAAS or GFAAS.
  - 5) All equipment required for personal air sampling, including pumps shall be provided by the Contractor at no extra cost to the Owner.
  - 6) Provide results of air samples in micrograms per cubic meter.
  - 7) A faxed summary of result must be provided to the Owner within 24 hours after the Owner authorizes the Contractor to perform the laboratory analysis of the collected air sample. The sampling result must include for each air sample taken the Project, the building address, the sample number, the room or room equivalent, and the reading.
  - 8) Turn-around time shall start after collection of the air samples, and includes travel time to and from the laboratory.
  - 9) A detailed final report covering the results of all air samples taken and analyzed must be submitted within 5 days from the time the Owner authorizes the performance of the laboratory analysis. The sampling report must include for each air sample, the Project, the building address, the sample number, the room or room equivalent, and the reading. The laboratory report contained in the final report must be signed by the Laboratory Director.
  - 10) The sampling data report must contain all required data fields as specified by the Owner. The sampling data report shall be provided to the Owner on 3.5 inch high density diskettes in ASCII file form. The required data fields will be provided by the Owner to the Contractor.
  - 11) The laboratory used for the analysis of the dust wipe samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
  - 12) Air sampling technician shall be present during the entire shift of the air sampling.
- d. TCLP Sampling and Analysis
- 1) Take core samples of construction waste as directed by the Owner and analyze by TCLP testing to determine if waste is hazardous.
  - 2) Waste shall be classified as hazardous if the concentration of lead is greater than 5 parts per million by TCLP testing.
  - 3) The laboratory used for the analysis of the TCLP samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
  - 4) A faxed summary of result must be provided to the Owner within 48 hours after the Owner authorizes the Contractor to perform the TCLP analysis of the waste. Provide results in parts per million (ppm).
  - 5) Final results provided to the Owner by the Contractor must include written sample preparation procedure and laboratory specific written procedures for performing TCLP, including quality control procedures used for performing the TCLP, and a table listing the sample numbers, description of the construction waste, and the



result of the TCLP. The laboratory report contained in the final report must be signed by the Laboratory Director.

- 6) Final report must also specify detection limits.
- 7) Final report must be provided within 5 days from the time the authorization to perform the TCLP is given by the Owner.

D. General Provisions

1. Some of the work of this contract may be in occupied apartments. The Contractor shall perform all of the work of this contract with the least inconvenience to the tenants.
2. The Contractor shall take all necessary precautions to protect the property of the Owner, its residents, and the public. The Contractor must repair any damaged property, whether of the Owner, its residents, or the public, and restore such property to its original condition. If the damage is beyond repair, the Contractor shall replace it with new, that in the judgment of the Owner, match the existing materials and/or of equal quality and workmanship. All such repairs shall be at the Contractor's expense.
3. The Contractor shall develop a work plan to be performed as requested by the Department of Planning and Development. The detailed plan shall include coordination of the monitoring and sampling work with the Contractor in a manner that will be least disruptive to the normal use of the non-work areas in the building. The plan should also include emergency procedures in case of fire.
4. The Contractor shall perform work in accordance with the latest HUD Guidelines, except as such Guidelines are modified by the Owner in writing in this Contract, or any Contract pursuant to this Contract, and in accordance with all applicable Federal, State and Local regulations.
5. The Contractor shall include in the bid price all supplementary miscellaneous items not specified but implied or required in order to complete the work.

E. Submissions

1. Six (6) copies of the submissions listed below must be submitted to the Owner by the Contractor or Subcontractor performing the Work:
  - a. Ability to perform lead dust wipe sampling by submitting evidence of the successful completion of lead inspector and/or risk assessor training by all staff to be assigned to the job including inspector technicians. As stated previously, training must be provided through an approved program.
  - b. Laboratory certification by the State Department of Health (or other responsible agency) through its ELAP program and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided.
  - c. If a subcontractor will be used for any of the laboratory work of this contract, evidence of certification stated in (2) above must also be provided for the subcontractor.

F. Waste Disposal

1. All waste generated must be legally disposed in accordance with the Federal, State and Local Regulations.

END OF SECTION 02 83 19 13c



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02 83 19 13	02 82 33 00	Removal Of Friable Asbestos-Containing Materials
02 83 19 13	02 82 33 00a	Removal Of Nonfriable Asbestos-Containing Materials
02 83 33 13	02 83 19 13	Removal And Disposal Of Lead-Containing Paint
02 83 33 13	02 83 19 13a	Lead Paint Related Abatement Procedures
02 83 33 13	02 83 19 13b	XRF Testing For Lead-Based Paint
02 83 33 13	02 83 19 13c	Lead Dust Wipe, Air And Tcpl Sampling And Analysis



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**SECTION 02 84 16 00 - REMOVAL OF FLUORESCENT LIGHT BALLASTS/CAPACITORS AND FLUORESCENT LIGHT TUBES****1.1 GENERAL****A. Description Of Work**

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

**B. Submittals**

1. Before Start of Work: Submit the following to the Owner's Representative for review. Do not start work until these submittals are returned with Owner's Representative's approval.
  - a. Copy of State or local license for hazardous waste hauler;
  - b. Certification of at least one on-site supervisor which has satisfactorily completed the OSHA 40 Hour Health and Safety Course for Handling Hazardous Materials;
  - c. Certificates of workers which have successfully completed at least the OSHA 40-Hour Health and Safety Course for Hazardous Materials;
  - d. List of employees scheduled to perform this work;
  - e. Schedule of start and finish times and dates for this work;
  - f. Name and address of landfill where these waste materials are to be deposited (include contact person and telephone numbers);
  - g. Material Safety Data Sheets for all materials requiring removal;
  - h. If contractor introduces any chemical into the work environmental, a MSDS for that chemical is required before use;
  - i. Transporter must have notified the EPA and/or the appropriate local government agency in advance of its intentions to transport PCB's, mercury and cadmium, and receive an identification number pursuant to the Toxic Substance Control Act (TSCA); and
  - j. Contingency Plan for handling emergency spills or leaks.

**1.2 PRODUCTS****A. Materials**

1. Polyethylene Sheet: A single polyethylene film in the largest sheet size possible to minimize seams, 4.0 and 6.0 mil thick, clear, frosted, or black.
2. Duct Tape: Provide duct tape in 3" widths, with an adhesive which is formulated to stick aggressively to sheet polyethylene.
3. Spray Cement: Provide spray adhesive in aerosol cans which is specifically formulated to stick tenaciously to sheet polyethylene.
4. Disposal Bays: Provide 6 mil thick leak-tight polyethylene bags.
5. Labels: As required by the EPA and OSHA for handling, transportation, and disposal of hazardous waste.
6. **Drums:** Recovery or salvage drums acceptable for disposal of hazardous waste. Prior approval of drums is required. Drums or containers must meet the required OSHA EPA (40 CFR Parts 264-265 and 300), and DOT regulations (49 CFR Parts 171-178). Use of damaged drums will not be allowed.

**1.3 EXECUTION****A. General**

Removal of Fluorescent Light Ballasts/Capacitors and  
Fluorescent Light Tubes



1. Where necessary, scaffolding shall be erected to fully access all applicable fluorescent light ballasts/capacitors and tubes. At no time will the ballasts/capacitors and tubes be allowed to drop onto the floor. Contractor must take care to protect from dropping the ballasts/capacitors and fluorescent tubes.
2. Prior to removing ballasts/capacitors and fluorescent tubes, contractor shall ensure that all electrical service to lights has been shut off, and locked out. Temporary lighting shall be erected to adequately illuminate work areas.
3. Depending on height of light fixtures, contractor shall utilize at least a 2-person per team system. The fluorescent light tubes shall be removed and passed to the appropriate number of workers required to lower the tubes to the floor without breaking them.
4. The worker on the floor shall lay the tubes in cardboard boxes large enough to hold a small quantity of tubes. Worker shall take care to not damage the tubes while they are lowered into the box. Once the box is full, it shall be wrapped with two layers of 6 mil thick polyethylene sheeting and sealed with duct tape.
5. Contractor may choose to either remove the fluorescent light ballasts/capacitors in-place or lower the lighting fixtures for easy access. The ballasts/capacitors shall be removed from the fixtures. Electrical wiring leading from the ballasts/capacitors shall be cut away. Ballasts/capacitors shall be placed in 55-gallon drums lined with at least two 6 mil thick polyethylene bags. Be careful not to overfill the drums so that they remain manageable. Once the drums have been filled to the acceptable level, seal the lid onto the top of the drum, and affix appropriate labels. Transport drums via hand dollies.

B. Worker Protection

1. As a minimum, while working with the ballasts/capacitors and light tubes, workers shall utilize impervious gloves adequate for the use with hazardous materials. If light ballasts/capacitors and/or light tubes are damaged, and/or exposure to these materials may reach the OSHA PEL or AGGIH threshold limit value (TLV), the contractor shall be required to provide impervious full body protection and respiratory protection. However, contractor is required to verify the type of protection required prior to working with these materials, and have written approval by Owner's Representative prior to beginning.
2. In addition, workers shall not smoke, drink or eat in these areas during work activities.

C. Storage Of Fluorescent Light Ballasts/Capacitors And Light Tubes

1. Once the containers holding the ballasts/capacitors and light tubes have been filled and sealed, they shall be stored in designated areas as agreed upon by the Owners Representative and Contractor. They shall not be allowed to be stored on-site in transportation vehicles until the time for them to be transported to the hazardous waste incinerators or landfill facility.

END OF SECTION 02 84 16 00

**SECTION 02 84 16 00a - 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**

1. 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 02 84 16 00a



## SECTION 02 84 16 00b - EXTERIOR LIGHTING

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. Section Includes:
  - a. Exterior luminaires with lamps and ballasts.
  - b. Luminaire-mounted photoelectric relays.
  - c. Poles and accessories.
  - d. Luminaire lowering devices.

#### C. Definitions

1. CCT: Correlated color temperature.
2. CRI: Color-rendering index.
3. HID: High-intensity discharge.
4. LER: Luminaire efficacy rating.
5. Luminaire: Complete lighting fixture, including ballast housing if provided.
6. Pole: Luminaire support structure, including tower used for large area illumination.
7. Standard: Same definition as "Pole" above.

#### D. Structural Analysis Criteria For Pole Selection

1. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
2. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4-M.
3. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied as stated in AASHTO LTS-4-M Ice Load Map.
4. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
  - a. Basic wind speed for calculating wind load for poles exceeding 49.2 feet (15 m) in height is 100 mph (45 m/s) **OR** 90 mph (40 m/s), **as directed**.
    - 1) Wind Importance Factor: 1.0.
    - 2) Minimum Design Life: 50 years.
    - 3) Velocity Conversion Factors: 1.0.
  - b. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is 100 mph (45 m/s) **OR** 90 mph (40 m/s).
    - 1) Wind Importance Factor: 1.0.
    - 2) Minimum Design Life: 25 years.
    - 3) Velocity Conversion Factors: 1.0.

#### E. Submittals

1. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
  - a. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
  - b. Details of attaching luminaires and accessories.
  - c. Details of installation and construction.
  - d. Luminaire materials.
  - e. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.



- 1) Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.  
**OR**  
Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
  - f. Photoelectric relays.
  - g. Ballasts, including energy-efficiency data.
  - h. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
  - i. Materials, dimensions, and finishes of poles.
  - j. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
  - k. Anchor bolts for poles.
  - l. Manufactured pole foundations.
  2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
    - a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    - b. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
    - c. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
    - d. Wiring Diagrams: For power, signal, and control wiring.
  3. Samples: For products designated for sample submission in the Exterior Lighting Device Schedule. Each Sample shall include lamps and ballasts.
  4. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.
  5. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.
  6. Field quality-control reports.
  7. Operation and Maintenance Data: For luminaires and poles **OR** luminaire lowering devices, **as directed**, to include in emergency, operation, and maintenance manuals.
  8. Warranty: Sample of special warranty.
- F. Quality Assurance
1. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.  
**OR**  
Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.
  2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  3. Comply with IEEE C2, "National Electrical Safety Code."
  4. Comply with NFPA 70.
- G. Delivery, Storage, And Handling
1. Package aluminum poles for shipping according to ASTM B 660.
  2. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
  3. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch (6 mm) deep. Do not apply tools to section of pole to be installed below ground line.



4. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
5. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

#### H. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
  - a. Warranty Period for Luminaires: Five years from date of Final Completion.
  - b. Warranty Period for Metal Corrosion: Five years from date of Final Completion.
  - c. Warranty Period for Color Retention: Five years from date of Final Completion.
  - d. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Final Completion.

## 1.2 PRODUCTS

### A. General Requirements For Luminaires

1. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
  - a. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
  - b. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
  - c. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.
2. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
3. Metal Parts: Free of burrs and sharp corners and edges.
4. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
5. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
6. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
7. Exposed Hardware Material: Stainless steel.
8. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
9. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
10. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
  - a. White Surfaces: 85 percent.
  - b. Specular Surfaces: 83 percent.
  - c. Diffusing Specular Surfaces: 75 percent.
11. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
12. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
13. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.



- a. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
  - b. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
    - 1) Color: As selected from manufacturer's standard catalog of colors **OR** As selected from manufacturer's full range, **as directed**.
14. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- a. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
  - b. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
  - c. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
  - d. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
    - 1) Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black, **as directed**.
15. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
- a. Label shall include the following lamp and ballast characteristics:
    - 1) "USES ONLY" and include specific lamp type.
    - 2) Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
    - 3) Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
    - 4) Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
    - 5) ANSI ballast type (M98, M57, etc.) for HID luminaires.
    - 6) CCT and CRI for all luminaires.
- B. Luminaire-Mounted Photoelectric Relays
1. Comply with UL 773 or UL 773A.
  2. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff, **as directed**.
    - a. Relay with locking-type receptacle shall comply with ANSI C136.10.
    - b. Adjustable window slide for adjusting on-off set points.
- C. Fluorescent Ballasts And Lamps
1. Ballasts for Low-Temperature Environments:
    - a. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic or electromagnetic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
    - b. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.
  2. Ballast Characteristics:
    - a. Power Factor: 90 percent, minimum.



- b. Sound Rating: Class A **OR** Class A except Class B for T8/HO ballasts, **as directed**.
  - c. Total Harmonic Distortion Rating: Less than 10 **OR** 20, **as directed**, percent.
  - d. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
  - e. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
  - f. Transient-Voltage Protection: Comply with IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
3. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures 0 deg F (minus 18 deg C) **OR** minus 20 deg F (minus 29 deg C), **as directed**, and higher.
- D. Ballasts For HID Lamps
1. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:
    - a. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
    - b. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C).
    - c. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
    - d. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
  2. Auxiliary, Instant-On, Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent of light output.
  3. High-Pressure Sodium Ballasts: Electromagnetic type with solid-state igniter/starter and capable of open-circuit operation without reduction of average lamp life. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.
    - a. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
      - 1) Restrike Range: 105- to 130-V ac.
      - 2) Maximum Voltage: 250-V peak or 150-V ac rms.
    - b. Minimum Starting Temperature: Minus 40 deg F (Minus 40 deg C).
- E. HID Lamps
1. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), CCT color temperature 1900 K, and average rated life of 24,000 hours, minimum.
    - a. Dual-Arc Tube Lamp: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.
  2. Low-Pressure Sodium Lamps: ANSI C78.43.
  3. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65, and CCT color temperature 4000 K.
  4. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and CCT color temperature 4000 K.
  5. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and CCT color temperature 4000 K.
- F. General Requirements For Poles And Support Components
1. Structural Characteristics: Comply with AASHTO LTS-4-M.
    - a. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
    - b. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
  2. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
  3. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.



- a. Materials: Shall not cause galvanic action at contact points.
- b. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
- c. Anchor-Bolt Template: Plywood or steel.
4. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws. Provide on all, except wood poles.
5. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."
6. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.
7. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

#### G. Steel Poles

1. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
  - a. Shape: Round, tapered **OR** Round, straight **OR** Square, tapered **OR** Square, straight, **as directed**.
  - b. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
2. Steel Mast Arms: Single-arm **OR** Truss **OR** Davit, **as directed**, type, continuously welded to pole attachment plate. Material and finish same as pole.
3. Brackets for Luminaires: Detachable, cantilever, without underbrace.
  - a. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless **OR** galvanized, **as directed**,-steel bolts.
  - b. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
  - c. Match pole material and finish.
4. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
5. Steps: Fixed steel, with nonslip treads, positioned for 15-inch (381-mm) vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet (3 m) above finished grade.
6. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch (76-by-127-mm) handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.
7. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems", listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
8. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
9. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.
10. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
11. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.
12. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - a. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."



- b. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
  - c. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
    - 1) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
- H. Aluminum Poles
- 1. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.
  - 2. Poles: ASTM B 209 (ASTM B 209M), 5052-H34 marine sheet alloy with access handhole in pole wall.
    - a. Shape: Round, tapered **OR** Round, straight **OR** Square, tapered **OR** Square, straight, **as directed**.
    - b. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
  - 3. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
  - 4. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems", listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
  - 5. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
    - a. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
    - b. Finish: Same as pole **OR** luminaire, **as directed**.
  - 6. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
  - 7. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
    - a. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
    - b. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
    - c. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
    - d. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
      - 1) Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from manufacturer's full range, **as directed**.
- I. Fiberglass Poles
- 1. Poles: Designed specifically for supporting luminaires, with factory-formed cable entrance and handhole. Not less than 65 percent fiberglass, with resin and pigment making up the remainder.
    - a. Resin Color: Dark bronze; provide uniform coloration throughout entire wall thickness.
    - b. Surface Finish: Pigmented polyurethane, with a minimum dry film thickness of 1.5 mils (0.04 mm). Polyurethane may be omitted if the surface layer of pole is inherently UV inhibited.
- J. Decorative Poles
- 1. Pole Material:
    - a. Cast ductile iron.
    - b. Cast gray iron, according to ASTM A 48/A 48M, Class 30.
    - c. Cast aluminum.
    - d. Cast concrete.



- e. Spun concrete.
- f. Steel tube, covered with closed-cell polyurethane foam, with a polyethylene exterior.
- 2. Mounting Provisions:
  - a. Bolted to concrete foundation.
  - b. Embedded.
- 3. Fixture Brackets:
  - a. Cast ductile iron.
  - b. Cast gray iron.
  - c. Cast aluminum.
- 4. Pole Finish: <Insert finish>.

#### K. Laminated Wood Poles

1. Species and Grades for Structural Glulam Timber: Engineer and fabricate structural laminated wood poles, complying with ANSI A190.1. Use southern pine **OR** Douglas fir **OR** Alaska cedar **OR** any species listed in AITC 117, **as directed**, to withstand indicated structural loads without exceeding allowable design working stresses according to AITC 117.
2. Features: Include wood bracket **OR** wood crossarm **OR** pole-top adapter, **as directed**, for mounting luminaire(s), metal pole cap, **as directed**, and concealed raceway path connected to access handhole.
3. Mounting Provisions: Embedded.
4. Appearance Grade: Architectural appearance grade complying with AITC 110.
5. Preservative Treatment: Pressure treat lumber before gluing according to AWPA C28 for waterborne preservatives. After dressing and end-cutting each member to final size and shape, apply a field-treatment preservative to comply with AWPA M4 to surfaces cut to a depth of more than 1/16 inch (1.6 mm).
6. Adhesive: Wet-use type complying with ASTM D 2559.
7. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.
8. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.
9. Finish: Natural, unstained wood **OR** Semitransparent stain applied after erection **OR** Semitransparent stain applied at factory, **as directed**, color as selected.

#### L. Wood Poles

1. Poles: Douglas fir **OR** Southern yellow pine, **as directed**, machine trimmed by turning, **as directed**, complying with ANSI O5.1 and with AWPA C4 for wood species used; and bored, roofed, and galled before treatment.
  - a. Mounting Provisions: Embedded.
2. Preservative Treatment: Pressure treat poles with creosote **OR** pentachlorophenol **OR** ammoniacal copper arsenate, **as directed**, according to AWPA C1 and AWPA C4.
3. Luminaire Brackets: Comply with ANSI C136.13.

#### M. Prestressed Concrete Poles

1. Poles: Manufactured by centrifugal spin-casting process **OR** of cast concrete, **as directed**.
  - a. Shape: Round, tapered **OR** Round, straight **OR** Square, tapered **OR** Square, straight, **as directed**.
  - b. Mounting Provisions: Steel butt flange for bolted mounting to foundation or breakaway support **OR** Embedded, **as directed**.
  - c. Finishing: Capped at top and plugged at bottom. Seat each steel reinforcing strand with epoxy adhesive.
  - d. Grounding: Continuous copper ground wire cast into pole. Terminate at top of pole and attach to 24-inch (610-mm) lightning rod, **as directed**.
2. Cure with wet steam and age for a minimum of 15 days before installation.
3. Fabricate poles with a hard, nonporous surface that is resistant to water, frost, and road and soil chemicals and that has a maximum water-absorption rate of 3 percent.



4. Cast aluminum nameplate into pole wall at approximately 5 feet (1.5 m) above ground line, listing name of manufacturer, Project identifier, overall height, and approximate weight.
5. Pole Brackets: Comply with ANSI C136.13.
6. Finish Color: Provided by color material complying with ASTM C 979, uniformly impregnated throughout the pole concrete. Color material shall provide a uniform, stable, permanent color and be as follows:
  - a. Inert, and carbon free.
  - b. Unaffected by environmental conditions and contaminants including, but not limited to, UV solar radiation, salts, and alkalis.
7. Finish Texture: Standard form **OR** Polished exposed aggregate **OR** Etched exposed aggregate, **as directed**.
  - a. Exposed aggregate shall be of **<Insert aggregate type selected from manufacturers' lists>** type.

#### N. Pole Accessories

1. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 16 Section "Wiring Devices" for ground-fault circuit-interrupter type.
  - a. Surface mounted **OR** Recessed, **as directed**, 12 inches (300 mm) above finished grade.
  - b. Nonmetallic polycarbonate plastic or reinforced fiberglass, weatherproof in use, cover, that when mounted results in NEMA 250, Type 3R **OR** Type 4X, **as directed**, enclosure.
  - c. With cord opening.
  - d. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.
2. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.
3. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.
4. Transformer Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and accept ballast(s) **OR** indicated accessories, **as directed**.
5. Decorative accessories, supplied by decorative pole manufacturer, include the following:
  - a. Banner Arms: **<Insert material>**.
  - b. Flag Holders: **<Insert material>**.
  - c. Ladder Rests: **<Insert material>**.

#### O. Lowering System For Luminaires

1. Arrange system to lower luminaire **OR** luminaire assembly, **as directed**, to a servicing position within 36 inches (900 mm) of finished grade in winds up to 30 mph (49 km/h) and to provide for manual plug connection to electrical power in the lowered position for testing.
2. Coordinate with luminaire and pole manufacturers for assembly details, wind-load and vibration analysis, and compatibility of materials for electrolysis-free attachment and connection for luminaire mounting assembly, lowering device, lowering cable, and portable winch.
3. Structural and Mechanical Design: Use a minimum safety factor of 5.0 for static and dynamic loads of load-bearing components, including cable.
4. Luminaire Mounting and Disconnect Arrangement: Multiple ring **OR** carriage, **as directed**, -mounted luminaires, arranged for lowering and rising as a group.
  - a. Electrical cable for normal operating power to luminaires manually disconnects inside pole base, using weatherproof multipin connector, and shall be arranged to move within the pole during lowering and rising of luminaire assembly.  
**OR**  
Electrical cable for normal operating power to luminaires automatically disconnects at a weatherproof multipin connector within the pole-top lowering head at the beginning of the lowering cycle and reconnects when luminaire or luminaire assembly is raised to the operating position.
5. Lowering Device: Weatherproof, cast-aluminum housing and multiple mechanical latches. Moving parts of latching assembly shall be located in the portion of the unit that is lowered to the servicing position. Positive latching in the operating position shall be indicated to the operator at the base of the pole by a clear visual signal, or by other means acceptable to the Owner or authorities having jurisdiction.



6. Lowering Cable: Zinc-electroplated- or stainless-steel aircraft cable.
7. Portable Winch: Manual **OR** 120-V electric, **as directed**, type. One required.
  - a. Winch Power Connection: Cord and plug.
  - b. Winch Raise-Lower Control: Remote-control station with 15 feet (5 m) of cable.
8. Winch Transformer: Portable, totally enclosed, encapsulated, single-phase, dry type. Primary rated at lighting-circuit voltage; secondary rated at 120 V. Permanent, primary and secondary, twist-locking plug connectors on pigtails shall match pole-base power outlet and winch plug.

### 1.3 EXECUTION

#### A. Luminaire Installation

1. Install lamps in each luminaire.
2. Fasten luminaire to indicated structural supports.
  - a. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
3. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation, **as directed**.

#### B. Pole Installation

1. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
2. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
  - a. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
  - b. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
  - c. Trees: 15 feet (5 m) from tree trunk.
3. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-place Concrete".
4. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
  - a. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
  - b. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
  - c. Install base covers unless otherwise indicated.
  - d. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
5. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
  - a. Dig holes large enough to permit use of tampers in the full depth of hole.
  - b. Backfill in 6-inch (150-mm) layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
6. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
  - a. Make holes 6 inches (150 mm) in diameter larger than pole diameter.
  - b. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi (20 MPa) at 28 days, and finish in a dome above finished grade.
  - c. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
  - d. Cure concrete a minimum of 72 hours before performing work on pole.
7. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent



- concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.
8. Raise and set poles using web fabric slings (not chain or cable).
- C. Bollard Luminaire Installation
1. Align units for optimum directional alignment of light distribution.
  2. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-place Concrete".
- D. Installation Of Individual Ground-Mounting Luminaires
1. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-place Concrete".
- E. Corrosion Prevention
1. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
  2. Steel Conduits: Comply with Division 26 Section "Raceway And Boxes For Electrical Systems". In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.
- F. Grounding
1. Ground metal poles and support structures according to Division 26 Section "Grounding And Bonding For Electrical Systems".
    - a. Install grounding electrode for each pole unless otherwise indicated.
    - b. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
  2. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding And Bonding For Electrical Systems".
    - a. Install grounding electrode for each pole.
    - b. Install grounding conductor and conductor protector.
    - c. Ground metallic components of pole accessories and foundations.
- G. Field Quality Control
1. Inspect each installed fixture for damage. Replace damaged fixtures and components.
  2. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
    - a. Verify operation of photoelectric controls.
  3. Illumination Tests:
    - a. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
      - 1) IESNA LM-5, "Photometric Measurements of Area and Sports Lighting Installations."
      - 2) IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
      - 3) IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
      - 4) IESNA LM-64, "Photometric Measurements of Parking Areas."
      - 5) IESNA LM-72, "Directional Positioning of Photometric Data."
  4. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
- H. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices.



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END OF SECTION 02 84 16 00b



## SECTION 02 84 33 00 - 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**



- 2) 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 AWPA 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.

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## SECTION 02 87 13 33 - MOLD REMEDIATION

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Submittals

1. List of all personnel to be involved in the work with their training and certifications.
2. List of all products and procedures proposed for use in performance of the work.
3. Test reports.
4. Certificates.

#### C. References

1. U.S. EPA "Mold Remediation in Schools and Commercial Buildings"
2. U.S. EPA "A Brief Guide to Mold, Moisture, and Your Home"

#### D. Quality Assurance

1. Conform to all Federal, State, and Local regulations which govern the handling and disposal of mold materials.

### 1.2 PRODUCT - (Not Used)

### 1.3 EXECUTION

- #### A. Environmental Assessment:
- The presence of mold, water damage, or musty odors shall be addressed immediately. In all instances, any source(s) of water must be stopped and the extent of water damaged determined. Water damaged materials shall be dried and repaired. Mold damaged materials shall be remediated in accordance with this document.

1. Visual Inspection: A visual inspection is the most important initial step in identifying a possible contamination problem. The extent of any water damage and mold growth shall be visually assessed. This assessment is important in determining remedial strategies. Ventilation systems shall also be visually checked, particularly for damp filters but also for damp conditions elsewhere in the system and overall cleanliness. Ceiling tiles, gypsum wallboard (sheetrock), cardboard, paper, and other cellulosic surfaces shall be given careful attention during a visual inspection. The use of equipment such as a boroscope, to view spaces in ductwork or behind walls, or a moisture meter, to detect moisture in building materials, may be helpful in identifying hidden sources of fungal growth and the extent of water damage.

2. Bulk/Surface Sampling

- a. Bulk or surface sampling is not required to undertake a remediation. Remediation of visually identified fungal contamination shall proceed without further evaluation.
- b. Bulk or surface samples may need to be collected to identify specific fungal contaminants as part of a medical evaluation if occupants are experiencing symptoms which may be related to fungal exposure or to identify the presence or absence of mold if a visual inspection is equivocal (e.g., discoloration, and staining).
- c. An individual trained in appropriate sampling methodology shall perform bulk or surface sampling. Bulk samples shall be collected from visibly moldy surfaces by scraping or cutting materials with a clean tool into a clean plastic bag. Surface samples shall be collected by wiping a measured area with a sterile swab or by stripping the suspect surface



with clear tape. Surface sampling is less destructive than bulk sampling. Other sampling methods may also be available. A laboratory specializing in mycology shall be consulted for specific sampling and delivery instructions.

3. Air Monitoring
  - a. Air sampling for fungi shall not be part of a routine assessment. This is because decisions about appropriate remediation strategies can usually be made on the basis of a visual inspection. In addition, air-sampling methods for some fungi are prone to false negative results and therefore cannot be used to definitively rule out contamination.
  - b. Air monitoring may be necessary if an individual(s) has been diagnosed with a disease that is or may be associated with a fungal exposure (e.g., pulmonary hemorrhage/hemosiderosis, and aspergillosis).
  - c. Air monitoring may be necessary if there is evidence from a visual inspection or bulk sampling that ventilation systems may be contaminated. The purpose of such air monitoring is to assess the extent of contamination throughout a building. It is preferable to conduct sampling while ventilation systems are operating.
  - d. Air monitoring may be necessary if the presence of mold is suspected (e.g., musty odors) but cannot be identified by a visual inspection or bulk sampling (e.g., mold growth behind walls). The purpose of such air monitoring is to determine the location and/or extent of contamination.
  - e. If air monitoring is performed, for comparative purposes, outdoor air samples shall be collected concurrently at an air intake, if possible, and at a location representative of outdoor air. For additional information on air sampling, refer to the American Conference of Governmental Industrial Hygienists' document, "Bioaerosols: Assessment and Control."
  - f. Personnel conducting the sampling shall be trained in proper air sampling methods for microbial contaminants. A laboratory specializing in mycology shall be consulted for specific sampling and shipping instructions.
4. Analysis of Environmental Samples
  - a. Microscopic identification of the spores/colonies requires considerable expertise. These services are not routinely available from commercial laboratories. Documented quality control in the laboratories used for analysis of the bulk/surface and air samples is necessary. The American Industrial Hygiene Association (AIHA) offers accreditation to microbial laboratories (Environmental Microbiology Laboratory Accreditation Program (EMLAP)). Accredited laboratories must participate in quarterly proficiency testing (Environmental Microbiology Proficiency Analytical Testing Program (EMPAT)).
5. Evaluation of bulk/surface and air sampling data shall be performed by an experienced health professional. The presence of few or trace amounts of fungal spores in bulk/surface sampling shall be considered background. Amounts greater than this or the presence of fungal fragments (e.g., hyphae, and conidiophores) may suggest fungal colonization, growth, and/or accumulation at or near the sampled location. Air samples shall be evaluated by means of comparison (i.e., indoors to outdoors) and by fungal type (e.g., genera, and species). In general, the levels and types of fungi found should be similar indoors (in non-problem buildings) as compared to the outdoor air. Differences in the levels or types of fungi found in air samples may indicate that moisture sources and resultant fungal growth may be problematic.

## B. Remediation

1. General
  - a. **In all situations, the underlying cause of water accumulation must be rectified or fungal growth will recur.** Any initial water infiltration shall be stopped and cleaned immediately. An immediate response (within 24 to 48 hours) and thorough clean up, drying, and/or removal of water damaged materials will prevent or limit mold growth. If the source of water is elevated humidity, relative humidity shall be maintained at levels below 60% to inhibit mold growth. Emphasis shall be on ensuring proper repairs of the building infrastructure, so that water damage and moisture buildup does not recur.
  - b. Five different levels of abatement are described below. The size of the area impacted by fungal contamination primarily determines the type of remediation. The sizing levels below



are based on professional judgment and practicality; currently there is not adequate data to relate the extent of contamination to frequency or severity of health effects. **The goal of remediation is to remove or clean contaminated materials in a way that prevents the emission of fungi and dust contaminated with fungi from leaving a work area and entering an occupied or non-abatement area, while protecting the health of workers performing the abatement.** The listed remediation methods were designed to achieve this goal, however, due to the general nature of these methods it is the responsibility of the people conducting remediation to ensure the methods enacted are adequate. The listed remediation methods are not meant to exclude other similarly effective methods. Any changes to the remediation methods listed in these guidelines, however, shall be carefully considered prior to implementation.

- c. Non-porous (e.g., metals, glass, and hard plastics) and semi-porous (e.g., wood, and concrete) materials that are structurally sound and are visibly moldy can be cleaned and reused. Cleaning shall be done using a detergent solution. Porous materials such as ceiling tiles and insulation, and wallboards with more than a small area of contamination shall be removed and discarded. Porous materials (e.g., wallboard, and fabrics) that can be cleaned, can be reused, but should be discarded if possible. A professional restoration consultant shall be contacted when restoring porous materials with more than a small area of fungal contamination. All materials to be reused shall be dry and visibly free from mold. Routine inspections shall be conducted to confirm the effectiveness of remediation work.
  - d. The use of gaseous, vapor-phase, or aerosolized biocides for remedial purposes is **not** recommended. The use of biocides in this manner can pose health concerns for people in occupied spaces of the building and for people returning to the treated space if used improperly. Furthermore, the effectiveness of these treatments is unproven and does not address the possible health concerns from the presence of the remaining non-viable mold. For additional information on the use of biocides for remedial purposes, refer to the American Conference of Governmental Industrial Hygienists' document, "Bioaerosols: Assessment and Control."
2. **Level I: Small Isolated Areas** (10 sq. ft or less) - e.g., ceiling tiles, small areas on walls
    - a. Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).
    - b. Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.
    - c. The work area shall be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons recovering from recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
    - d. Containment of the work area is not necessary. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
    - e. Contaminated materials that cannot be cleaned shall be removed from the building in a sealed plastic bag. There are no special requirements for the disposal of moldy materials.
    - f. The work area and areas used by remedial workers for egress shall be cleaned with a damp cloth and/or mop and a detergent solution.
    - g. All areas shall be left dry and visibly free from contamination and debris.
  3. **Level II: Mid-Sized Isolated Areas** (10 - 30 sq. ft.) - e.g., individual wallboard panels.
    - a. Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).
    - b. Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.



- c. The work area shall be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
  - d. The work area shall be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
  - e. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
  - f. Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
  - g. The work area and areas used by remedial workers for egress shall be HEPA vacuumed (a vacuum equipped with a High-Efficiency Particulate Air filter) and cleaned with a damp cloth and/or mop and a detergent solution.
  - h. All areas shall be left dry and visibly free from contamination and debris.
4. **Level III: Large Isolated Areas** (30 - 100 square feet) - e.g., several wallboard panels.
- a. A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for the project.
  - b. The following procedures *at a minimum* are recommended:
    - 1) Personnel trained in the handling of hazardous materials and equipped with respiratory protection, (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.
    - 2) The work area and areas directly adjacent shall be covered with a plastic sheet(s) and taped before remediation, to contain dust/debris.
    - 3) Seal ventilation ducts/grills in the work area and areas directly adjacent with plastic sheeting.
    - 4) The work area and areas directly adjacent shall be unoccupied. Further vacating of people from spaces near the work area is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
    - 5) Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
    - 6) Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
    - 7) The work area and surrounding areas shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
    - 8) All areas shall be left dry and visibly free from contamination and debris.
  - c. If abatement procedures are expected to generate a lot of dust (e.g., abrasive cleaning of contaminated surfaces, demolition of plaster walls) or the visible concentration of the fungi is heavy (blanket coverage as opposed to patchy), then it is recommended that the remediation procedures for Level IV are followed.
5. **Level IV: Extensive Contamination** (greater than 100 contiguous square feet in an area)
- a. A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for the project. The following procedures are recommended:
    - 1) Personnel trained in the handling of hazardous materials equipped with:
      - a) Full-face respirators with high efficiency particulate air (HEPA) cartridges
      - b) Disposable protective clothing covering both head and shoes
      - c) Gloves
    - 2) Containment of the affected area:



- a) Complete isolation of work area from occupied spaces using plastic sheeting sealed with duct tape (including ventilation ducts/grills, fixtures, and any other openings)
  - b) The use of an exhaust fan with a HEPA filter to generate negative pressurization
  - c) Airlocks and decontamination room
- 3) Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
  - 4) Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. The outside of the bags shall be cleaned with a damp cloth and a detergent solution or HEPA vacuumed in the decontamination chamber prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of moldy materials.
  - 5) The contained area and decontamination room shall be HEPA vacuumed and cleaned with a damp cloth and/or mop with a detergent solution and be visibly clean prior to the removal of isolation barriers.
  - 6) Air monitoring shall be conducted prior to occupancy to determine if the area is fit to reoccupy.
6. **Level V: Remediation of HVAC Systems**
- a. A Small Isolated Area of Contamination (<10 square feet) in the HVAC System
    - 1) Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).
    - 2) Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.
    - 3) The HVAC system shall be shut down prior to any remedial activities.
    - 4) The work area shall be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
    - 5) Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
    - 6) Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, shall be removed. Other contaminated materials that cannot be cleaned shall be removed in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
    - 7) The work area and areas immediately surrounding the work area shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
    - 8) All areas shall be left dry and visibly free from contamination and debris.
    - 9) A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. HVAC manufacturers shall be consulted for the products they recommend for use in their systems.
  - b. Areas of Contamination (>10 square feet) in the HVAC System: A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for remediation projects involving more than a small isolated area in an HVAC system. The following procedures are recommended:
    - 1) Personnel trained in the handling of hazardous materials equipped with:
      - a) Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended.
      - b) Gloves and eye protection



- c) Full-face respirators with HEPA cartridges and disposable protective clothing covering both head and shoes shall be worn if contamination is greater than 30 square feet.
  - 2) The HVAC system shall be shut down prior to any remedial activities.
  - 3) Containment of the affected area:
    - a) Complete isolation of work area from the other areas of the HVAC system using plastic sheeting sealed with duct tape.
    - b) The use of an exhaust fan with a HEPA filter to generate negative pressurization.
    - c) Airlocks and decontamination room if contamination is greater than 30 square feet.
  - 4) Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, shall be removed. Other contaminated materials that cannot be cleaned should be removed in sealed plastic bags. When a decontamination chamber is present, the outside of the bags shall be cleaned with a damp cloth and a detergent solution or HEPA vacuumed prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of moldy materials.
  - 5) The contained area and decontamination room shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution prior to the removal of isolation barriers.
  - 6) All areas shall be left dry and visibly free from contamination and debris.
  - 7) Air monitoring shall be conducted prior to re-occupancy with the HVAC system in operation to determine if the area(s) served by the system are fit to reoccupy.
  - 8) A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. HVAC manufacturers shall be consulted for the products they recommend for use in their systems.
7. Hazard Communication: When fungal growth requiring large-scale remediation is found, the building owner, management, and/or employer shall notify occupants in the affected area(s) of its presence. Notification shall include a description of the remedial measures to be taken and a timetable for completion. Group meetings held before and after remediation with full disclosure of plans and results can be an effective communication mechanism. Individuals with persistent health problems that appear to be related to bioaerosol exposure should see their physicians for a referral to practitioners who are trained in occupational/environmental medicine or related specialties and are knowledgeable about these types of exposures. Individuals seeking medical attention shall be provided with a copy of all inspection results and interpretation to give to their medical practitioners.

END OF SECTION 02 87 13 33



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**SECTION 02 87 16 13 - BIRD AND BIRD WASTE ABATEMENT****1.1 GENERAL****A. Description Of Work**

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

**B. Summary Of Work**

1. Work Included - Conventional Enclosure for Removal of Birds and Bird Waste
  - a. Seal off penetrations on perimeter walls into the work area (critical barriers) and establish a decontamination facility for workers.
  - b. Coordinate activities with the demolition and well capping activities.
2. Work Included - Removal and disposal of birds and bird waste.
  - a. Establish work area by installing construction barrier tape around removal area.
  - b. Remove and properly dispose of bulk contamination debris.
  - c. Mist bird waste and contaminated material with Biocide or the equivalent (i.e. Sanogene, Oxine, or Envirocon).
  - d. Remove and properly dispose of contaminated waste material from all building components.
  - e. Utilize low pressure washers or scrub brushes to clean all wall surfaces of bird waste.

**C. Quality Criteria**

1. Qualifications for Performance of Work
  - a. Contractor (or subcontractor engaged to perform the Work of this Section) shall:
    - 1) Be a licensed bird waste abatement contractor in accordance with the Statutes of the State in which the work is to be performed. Submit notarized documentation confirming current licensure.
    - 2) Have a record of not less than five years successful experience in bird waste removal or asbestos removal.
2. Reference Standards
  - a. Acknowledge, by the executing of the Contract, awareness and familiarity with the contents and requirements of the following regulations, codes, and standards, and assume responsibility for the performance of the Work in strict compliance therewith and for every instance of failure to comply therewith.
  - b. Where conflict among requirements or with the Contract Documents exists, the more stringent requirements shall apply.
    - 1) USEPA Regional National Emissions Standards for Hazardous Air Pollutants (NESHAPS)
    - 2) U.S. Occupational and Safety and Health Administration (OSHA)
    - 3) U.S. EPA Office of Pesticide and Toxic Substances Guidance Document
    - 4) U.S. Department of Transportation, Hazardous Substances: Final Rule (49 CFR 171 and 172), Federal Register November 21, 1986 and corrected February 17, 1987.
    - 5) Statutes of the State in which the Work is to be Performed: Licensure for Asbestos Consultants and Contractors.
    - 6) All state, county, and city codes and ordinances as applicable. Make available for review at the site one copy of EPA, OSHA, and applicable State, County, and City Regulations governing the Work.
3. Patent/Copyright Compliance: Contractor shall determine the applicability of any process patents that may be employed and shall be responsible for the payment of all fees, royalties and licenses that may be required for the use of any patented or licensed process. Contractor shall hold the Owner, Engineer and Testing Laboratory harmless for failure to obtain any licenses and to pay any applicable fees and royalties.



- D. Product Handling
1. Deliver all materials in the original packages, containers, or bundles bearing the name of the manufacturer and the brand name.
  2. Store all materials subject to damage off the ground, away from wet or damp surfaces, and under cover sufficient to prevent damage or contamination.
  3. Remove from the premises all damaged or deteriorating materials. Dispose of materials that become contaminated with waste in accordance with applicable regulatory standards.
- E. Worksite Conditions
1. Worker and Visitor Procedures: The Contractor is hereby advised that the birds and bird wastes have been determined to cause diseases by inhalation and Contractor shall provide workers and qualified visitors with respirators that, as a minimum, shall meet the requirements of current applicable OSHA regulations, and protective clothing during preparation of system of enclosures, prior to commencing, during actual removal, and until final clean-up is completed. Also all personnel assigned to work on this project shall attend a training/awareness class for the purpose of explaining the hazards of improperly handling these materials and proper control measures to take in order to protect themselves.
- F. Personnel Protection
1. General
    - a. Provide respiratory protection in accordance with OSHA regulations 29 CFR 1910-134 and in accordance with the following paragraphs.
      - 1) Prior to commencement of work, all workers shall be instructed by the Contractor and shall be knowledgeable in the appropriate procedures of personnel protection and waste removal.
      - 2) Where respirators with disposable filters are used, provide sufficient filters for replacement as necessary by the workers, or as required by applicable regulations.
      - 3) Permit no visitors, except for governmental inspectors having jurisdiction, or as authorized by Engineer or the Owner, in the work areas after commencement of waste disturbance or removal. Provide authorized visitors with suitable respirators.
      - 4) Provide workers with sufficient sets of protective disposable clothing, consisting of full-body coveralls, head covers, gloves, and foot covers, of sizes to properly fit individual workers.
      - 5) Provide authorized visitors with a set of suitable protective disposable clothing, headgear, eye protection, and/or footwear of sizes to properly fit visitors whenever they are required to enter the work area, to a maximum of six sets per day.
      - 6) Provide, in addition to respirators and protective clothing provided for authorized visitors, protective clothing and respirators for use by Testing Laboratory's representative. Furnish protective clothing in as many sets as required for full-time monitoring by Testing Laboratory.
      - 7) Provide and post the decontamination and work procedures to be followed by workers.
  2. Respiratory Protection Program
    - a. Maintain a respiratory protection program that contains all the elements of the OSHA regulations. Provide a copy to the Engineer for approval.
    - b. Appoint a respiratory protection program administrator, who shall be responsible for the program, maintaining all documentation, instructing workers and providing fit tests. Respiratory protection administrator is to be qualified under OSHA requirements and to have attended and passed, as a minimum, OSHA training institute 2-week course on respiratory protection or NIOSH course "Occupational Respiratory Protection." Respiratory protection program administrator is to be on-site daily during abatement activities. All written programs and directions are to be in English and/or the language of the abatement workers if they are not fluent in English.
    - c. The Contractor is advised that the minimum respiratory requirements as called for in this section and on any drawings/sketches shall be applied unless reported measures indicate



that a lower form of respiratory protection is acceptable according to the appropriate OSHA regulations and the more strict sections of the specification.

3. Respiratory Protection Requirements
  - a. Workers shall be provided with respiratory protection equipment. The respirators are to be sanitized and maintained in accordance with the manufacturer's specification. Appropriate respirator selection will be dependent upon the work to be performed and the level of exposure, as given below.
  - b. For the clean-up, as a minimum, the use of full-faced air-purifying respirators is required for all preparation, removal and cleaning work.
  - c. This specification requires that workers shall wear suitable respiratory protection at all times whenever a potential for exposure to bird and bird waste exists.

## 1.2 PRODUCTS

### A. Materials

1. Polyethylene/Plastic sheeting shall be of the thicknesses specified, in sizes to minimize the frequency of joints. Utilize reinforced plastic sheeting in specified thicknesses on floors.
2. Tape shall be glass fiber or other type capable of sealing joints of adjacent sheets of plastic and for attachment of plastic sheet to finished or unfinished surfaces of dissimilar materials under both dry and wet conditions.
3. Sodium Hypochlorite ("bleach")
4. Impermeable Containers shall be suitable to receive and retain contaminated materials until disposal at an approved site and shall be labeled in accordance with U.S. DOT 49 CFR 171 and 172, and containers shall be both air- and water-tight. Use a minimum of two types of impermeable containers: 1) six millimeter-thick (mil) plastic bags sized to fit within the drum; and 2) metal or fiber drums with tightly fitting lids.
5. Other Materials: Provide all other materials, such as lumber, nails, and hardware, that may be required to construct and dismantle the decontamination area and the barriers that isolate the work area(s).
6. Caulking shall be non-shrinking caulk to be used where insulated pipes continue through areas such as walls and ceilings. Contractor shall determine and submit proof that caulk proposed for use is compatible with the temperature conditions of the surfaces to which it is to be applied.
  - a. Tools And Equipment
    - 1) Water Sprayer - utilize airless or other low pressure sprayer for amended water application.
    - 2) Air Purifying Equipment (for internal recirculation in the work area) shall be HEPA Filtration Systems or Electronic Precipitators. Ensure that no internal air movement system or purification equipment exhausts contaminated air from the work area(s) outside the work area.
    - 3) Diminished Air Pressure Equipment shall comply with ANSI 29.2-7, local exhaust ventilation.
    - 4) Scaffolding shall be as required to accomplish the specified work and shall meet all applicable safety regulations.
    - 5) Transportation - as required for loading, temporary storage, transit, and unloading of contaminated waste without exposure to persons or property.

## 1.3 EXECUTION

### A. Procedures

1. All personnel assigned to perform the work shall attend a training/awareness class for the purpose of explaining the hazards of improperly handling the waste and the proper control measures to take in order to protect themselves. These work procedures shall be discussed with each individual followed by the individual acknowledging receipt of this training by completing the pertinent information on a Hazardous Awareness Training Form



2. The majority of diseases related to bird waste is related to the inhalation of the airborne dust released by the waste. All personnel performing removal/decontamination waste shall therefore wear Powered Air Purifying Respirators (PAPR) equipped with combination Organic Vapor and High Efficiency Particulate Air (HEPA) filters while handling the waste.
3. Workers shall wear non-porous gloves and boots during all preparatory and removal operations.
4. When entering the building, the removal/decontamination personnel shall mist all surfaces having visible remnants of waste, using a diluted sodium hypochlorite ("bleach") and water solution. This solution shall be diluted at a ratio of 10 parts water to 1 part bleach for a 10 to 1 ration (10:1). The waste shall be continuously misted during occupancy in order to keep airborne dust emissions from the waste to a minimum.
5. Remove all birds from the building and seal all openings into the building. The main purpose of this is to eliminate the availability for future bird access into the building. The openings may be temporarily sealed or closed up in many ways, including boarding up windows/doors, polyethylene sheeting, or other convenient and cost effective means. It is not the intention of this task to complete seal the building airtight.
6. Designate an area of the facility for the purpose of storing the waste prior to loading for transportation to the appropriate landfill. The area designated shall have easy access to the door which will be utilized as the waste load-out.

END OF SECTION 02 87 16 13



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02 89 00 00	01 22 16 00	No Specification Required
02 89 00 00	02 83 19 13	Removal And Disposal Of Lead-Containing Paint
02 89 00 00	02 83 19 13a	Lead Paint Related Abatement Procedures
02 89 00 00	02 83 19 13b	XRF Testing For Lead-Based Paint
02 89 00 00	02 83 19 13c	Lead Dust Wipe, Air And Tcpl Sampling And Analysis



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## SECTION 05 05 19 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 metallically bonded to rung.
    - h. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than 1/2 inch (12 mm) **OR** 3/4 inch (19 mm), **as directed**, in least dimension.
    - i. Support each ladder at top and bottom and not more than 60 inches (1500 mm) o.c. with welded or bolted steel brackets.
    - j. Galvanize ladders **OR** exterior ladders, **as directed**, including brackets and fasteners.  
**OR**  
Prime ladders **OR** exterior ladders, **as directed**, including brackets and fasteners, with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.
  3. Aluminum Ladders:
    - a. Space siderails 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**, apart unless otherwise indicated.
    - b. Siderails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches (64 mm) deep, 3/4 inch (19 mm) wide, and 1/8 inch (3.2 mm) thick.
    - c. Rungs: Extruded-aluminum tubes, not less than 3/4 inch (19 mm) deep and not less than 1/8 inch (3.2 mm) thick, with ribbed tread surfaces.
    - d. Fit rungs in centerline of siderails; fasten by welding or with stainless-steel fasteners or brackets and aluminum rivets.
    - e. Provide platforms as indicated fabricated from pressure-locked aluminum bar grating or extruded-aluminum plank grating, supported by extruded-aluminum framing. Limit openings in gratings to no more than 1/2 inch (12 mm) **OR** 3/4 inch (19 mm), **as directed**, in least dimension.
    - f. Support each ladder at top and bottom and not more than 60 inches (1500 mm) o.c. with welded or bolted aluminum brackets.
    - g. Provide minimum 72-inch- (1830-mm-) high, hinged security door with padlock hasp at foot of ladder to prevent unauthorized ladder use.
- K. Ladder Safety Cages
1. General:
    - a. Fabricate ladder safety cages to comply with ANSI A14.3 **OR** OSHA regulations, **as directed**. Assemble by welding or with stainless-steel fasteners.
    - b. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet (6 m) o.c. Provide secondary intermediate hoops spaced not more than 48 inches (1200 mm) o.c. between primary hoops.
    - c. Fasten assembled safety cage to ladder rails and adjacent construction by welding or with stainless-steel fasteners unless otherwise indicated.
  2. Steel Ladder Safety Cages:
    - a. Primary Hoops: 1/4-by-4-inch (6.4-by-100-mm) flat bar hoops.



- b. Secondary Intermediate Hoops: 1/4-by-2-inch (6.4-by-50-mm) flat bar hoops.
  - c. Vertical Bars: 3/16-by-1-1/2-inch (4.8-by-38-mm) flat bars secured to each hoop.
  - d. Galvanize ladder safety cages, including brackets and fasteners.  
**OR**  
Prime ladder safety cages, including brackets and fasteners, with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.
3. Aluminum Ladder Safety Cages:
- a. Primary Hoops: 1/4-by-4-inch (6.4-by-100-mm) flat bar hoops.
  - b. Secondary Intermediate Hoops: 1/4-by-2-inch (6.4-by-50-mm) flat bar hoops.
  - c. Vertical Bars: 1/4-by-2-inch (6.4-by-50-mm) flat bars secured to each hoop.

L. Alternating Tread Devices

- 1. Alternating Tread Devices: Fabricate alternating tread devices to comply with ICC's International Building Code. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.
  - a. Fabricate from steel **OR** stainless steel **OR** aluminum, **as directed**, and assemble by welding or with stainless-steel fasteners.
  - b. Comply with applicable railing requirements in Division 05 Section "Pipe And Tube Railings".
- 2. Galvanize steel **OR** exterior steel, **as directed**, alternating tread devices, including treads, railings, brackets, and fasteners.  
**OR**  
Prime steel **OR** exterior steel, **as directed**, alternating tread devices, including treads, railings, brackets, and fasteners, with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

M. Metal Ships' Ladders And Pipe Crossovers

- 1. Provide metal ships' ladders and pipe crossovers where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.
  - a. Fabricate ships' ladders and pipe crossovers, including railings from steel **OR** stainless steel **OR** aluminum, **as directed**.
  - b. Fabricate treads **OR** treads and platforms, **as directed**, from welded or pressure-locked steel bar grating **OR** pressure-locked stainless-steel bar grating **OR** pressure-locked aluminum bar grating **OR** extruded-aluminum plank grating, **as directed**. Limit openings in gratings to no more than 1/2 inch (12 mm) **OR** 3/4 inch (19 mm), **as directed**, in least dimension.
  - c. Fabricate treads **OR** treads and platforms, **as directed**, from rolled-steel floor plate **OR** rolled-stainless-steel floor plate **OR** rolled-aluminum-alloy tread plate **OR** abrasive-surface floor plate, **as directed**.
  - d. Comply with applicable railing requirements in Division 5 Section "Pipe and Tube Railings."
- 2. Galvanize steel **OR** exterior steel, **as directed**, ships' ladders and pipe crossovers, including treads, railings, brackets, and fasteners.  
**OR**  
Prime steel **OR** exterior steel, **as directed**, ships' ladders and pipe crossovers, including treads, railings, brackets, and fasteners, with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

N. Metal Floor Plate

- 1. Fabricate from rolled-steel floor **OR** rolled-stainless-steel floor **OR** rolled-aluminum-alloy tread **OR** abrasive-surface floor, **as directed**, plate of thickness indicated below:
  - a. Thickness: 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm) **OR** 5/16 inch (8 mm) **OR** 3/8 inch (9.5 mm) **OR** As indicated, **as directed**.
- 2. Provide grating sections where indicated fabricated from welded or pressure-locked steel bar grating **OR** pressure-locked stainless steel bar grating **OR** pressure-locked aluminum bar grating



- OR** extruded-aluminum plank grating, **as directed**. Limit openings in gratings to no more than 1/2 inch (12 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, in least dimension.
3. Provide steel **OR** stainless-steel **OR** aluminum, **as directed**, angle supports as indicated.
  4. Include steel **OR** stainless-steel **OR** aluminum, **as directed**, angle stiffeners, and fixed and removable sections as indicated.
  5. Provide flush steel **OR** stainless-steel **OR** aluminum, **as directed**, bar drop handles for lifting removable sections, one at each end of each section.
- O. Structural-Steel Door Frames
1. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch (16-by-38-mm) steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than 10 inches (250 mm) o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.
    - a. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.
  2. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.
  3. Galvanize steel **OR** exterior steel, **as directed**, frames.  
**OR**  
Prime steel **OR** exterior steel, **as directed**, frames with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.
- P. Miscellaneous Steel Trim
1. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
  2. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
    - a. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
  3. Galvanize miscellaneous steel **OR** exterior miscellaneous steel, **as directed**, trim.  
**OR**  
Prime miscellaneous steel **OR** exterior miscellaneous steel, **as directed**, trim with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.
- Q. Metal Bollards
1. Fabricate metal bollards from Schedule 40 steel pipe **OR** Schedule 80 steel pipe **OR** 1/4-inch (6.4-mm) wall-thickness rectangular steel tubing **OR** steel shapes, as indicated, **as directed**.
    - a. Cap bollards with 1/4-inch- (6.4-mm-) thick steel plate (not required if bollards are concrete filled).
    - b. Where bollards are indicated to receive controls for door operators, provide necessary cutouts for controls and holes for wire.
    - c. Where bollards are indicated to receive light fixtures, provide necessary cutouts for fixtures and holes for wire.
  2. Fabricate bollards with 3/8-inch- (9.5-mm-) thick steel baseplates for bolting to concrete slab (for mounting bollards on structural slab or on existing pavement). Drill baseplates at all four corners for 3/4-inch (19-mm) anchor bolts.
    - a. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.
  3. Fabricate sleeves for bollard anchorage from steel pipe or tubing with 1/4-inch- (6.4-mm-) thick steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches (200 mm) deep and 3/4 inch (19 mm) larger than OD of bollard.



4. Fabricate internal sleeves for removable bollards from Schedule 40 steel pipe or 1/4-inch (6.4-mm) wall-thickness steel tubing with an OD approximately 1/16 inch (1.5 mm) less than ID of bollards. Match drill sleeve and bollard for 3/4 inch (19 mm) steel machine bolt.
  5. Prime bollards with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.
- R. Pipe Or Downspout Guards
1. Fabricate pipe **OR** downspout, **as directed**, guards from 3/8-inch- (9.5-mm-) thick by 12-inch- (300-mm-) wide steel plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2-inch (50-mm) clearance between pipe and pipe guard. Drill each end for two 3/4-inch (19-mm) anchor bolts.
  2. Galvanize pipe **OR** downspout, **as directed**, guards.  
**OR**  
Prime pipe **OR** downspout, **as directed**, guards with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.
- S. Abrasive Metal Nosings, Treads And Thresholds
1. Cast-Metal Units: Cast iron **OR** aluminum **OR** bronze (leaded red or semired brass) **OR** nickel silver (leaded nickel bronze), **as directed**, with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
    - a. Nosings: Cross-hatched units, 4 inches (100 mm) wide with 1/4-inch (6-mm) **OR** 1-inch (25-mm), **as directed**, lip, for casting into concrete steps.  
**OR**  
Nosings: Cross-hatched units, 1-1/2 by 1-1/2 inches (38 by 38 mm), for casting into concrete curbs.
    - b. Treads: Cross-hatched units, full depth of tread with 3/4-by-3/4-inch (19-by-19-mm) nosing, for application over bent plate treads or existing stairs.
    - c. Thresholds: Fluted-saddle-type units, 5 inches (125 mm) wide by 1/2 inch (12 mm) high, with tapered edges.  
**OR**  
Thresholds: Fluted-interlocking- (hook-strip-) type units, 5 inches (125 mm) wide by 5/8 inch (16 mm) high, with tapered edge.  
**OR**  
Thresholds: Plain-stepped- (stop-) type units, 5 inches (125 mm) wide by 1/2 inch (12 mm) high, with 1/2-inch (12-mm) step.
  2. Extruded Units: Aluminum **OR** Bronze, **as directed**, with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.
    - a. Provide ribbed units, with abrasive filler strips projecting 1/16 inch (1.5 mm) above aluminum extrusion.  
**OR**  
Provide solid-abrasive-type units without ribs.
    - b. Nosings: Square-back units, 1-7/8 inches (48 mm) **OR** 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, wide, for casting into concrete steps.  
**OR**  
Nosings: Beveled-back units, 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, wide with 1-3/8-inch (35-mm) lip, for surface mounting on existing stairs.  
**OR**  
Nosings: Two-piece units, 3 inches (75 mm) wide, with subchannel for casting into concrete steps.
    - c. Treads: Square **OR** Beveled, **as directed**, -back units, full depth of tread with 1-3/8-inch (35-mm) lip, for application over existing stairs.
  3. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.



4. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches (100 mm) from ends and not more than 12 inches (300 mm) o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.
    - a. Provide two rows of holes for units more than 5 inches (125 mm) wide, with two holes aligned at ends and intermediate holes staggered.
  5. Apply bituminous paint to concealed surfaces of cast-metal units.
  6. Apply clear lacquer to concealed surfaces of extruded units.
- T. Cast-Iron Wheel Guards
1. Provide wheel guards made from cast iron, 3/4 inch (19 mm) thick, hollow-core construction, of size and shape indicated. Provide holes for countersunk anchor bolts and grouting.
  2. Prime cast iron wheel guards with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.
- U. Metal Downspout Boots
1. Provide downspout boots made from cast iron **OR** cast aluminum, **as directed**, in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.
    - a. Outlet: Vertical, to discharge into pipe **OR** Horizontal, to discharge into pipe **OR** At 35 degrees from horizontal, to discharge onto splash block or pavement, **as directed**.
  2. Prime cast iron downspout boots with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.
- V. Loose Bearing And Leveling Plates
1. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
  2. Galvanize plates.  
**OR**  
Prime plates with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.
- W. Loose Steel Lintels
1. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
  2. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches (200 mm) unless otherwise indicated.
  3. Galvanize loose steel lintels located in exterior walls.
  4. Prime loose steel lintels located in exterior walls with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.
- X. Steel Weld Plates And Angles
1. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.
- Y. Finishes, General
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  2. Finish metal fabrications after assembly.
  3. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.
- Z. Steel And Iron Finishes



1. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
  - a. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
2. Shop prime iron and steel items not indicated to be galvanized, **as directed**, unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
  - a. Shop prime with universal shop primer **OR** primers specified in Division 07, **as directed**, unless zinc-rich primer is **OR** primers specified in Division 09 Section "High-performance Coatings" are, **as directed**, indicated.
3. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" **OR** SSPC-SP 3, "Power Tool Cleaning" **OR** requirements indicated below, **as directed**:
  - a. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - b. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - c. Items Indicated to Receive Primers Specified in Division 9 Section "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - d. Other Items: SSPC-SP 3, "Power Tool Cleaning."
4. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
  - a. Stripe paint corners, crevices, bolts, welds, and sharp edges.

#### AA. Aluminum Finishes

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).
3. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

### 1.3 EXECUTION

#### A. Installation, General

1. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
2. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
3. Field Welding: Comply with the following requirements:
  - a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - b. Obtain fusion without undercut or overlap.
  - c. Remove welding flux immediately.
  - d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
4. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
5. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.



6. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
  - a. Cast Aluminum: Heavy coat of bituminous paint.
  - b. Extruded Aluminum: Two coats of clear lacquer.
  
- B. Installing Miscellaneous Framing And Supports
  1. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
  2. Anchor supports for operable partitions securely to and rigidly brace from building structure.
  3. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
    - a. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.
  4. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
    - a. Grout baseplates of columns supporting steel girders after girders are installed and leveled.
  
- C. Installing Prefabricated Building Columns
  1. Install prefabricated building columns to comply with AISC's "Specification for Structural Steel Buildings" and with requirements applicable to listing and labeling for fire-resistance rating indicated.
  
- D. Installing Metal Bollards
  1. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
    - a. Do not fill removable bollards with concrete.
  2. Anchor bollards to existing construction with expansion anchors **OR** anchor bolts **OR** through bolts, **as directed**. Provide four 3/4-inch (19-mm) bolts at each bollard unless otherwise indicated.
    - a. Embed anchor bolts at least 4 inches (100 mm) in concrete.
  3. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete **OR** in formed or core-drilled holes not less than 8 inches (200 mm) deep and 3/4 inch (19 mm) larger than OD of bollard, **as directed**. Fill annular space around bollard solidly with nonshrink, nonmetallic grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch (3 mm) toward bollard.
  4. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
  5. Anchor internal sleeves for removable bollards in concrete by inserting into pipe sleeves preset into concrete **OR** formed or core-drilled holes not less than 8 inches (200 mm) deep and 3/4 inch (19 mm) larger than OD of sleeve, **as directed**. Fill annular space around internal sleeves solidly with nonshrink, nonmetallic grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch (3 mm) toward internal sleeve.
  6. Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.
  7. Place removable bollards over internal sleeves and secure with 3/4-inch (19-mm) machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. the Owner will furnish padlocks.
  8. Fill bollards solidly with concrete, mounding top surface to shed water.
    - a. Do not fill removable bollards with concrete.
  
- E. Installing Pipe Guards



1. Provide pipe guards at exposed vertical pipes in parking garage where not protected by curbs or other barriers. Install by bolting to wall or column with expansion anchors. Provide four 3/4-inch (19-mm) bolts at each pipe guard. Mount pipe guards with top edge 26 inches (660 mm) above driving surface.
- F. Installing Nosings, Treads, And Thresholds
1. Center nosings on tread widths unless otherwise indicated.
  2. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.
  3. Seal thresholds exposed to exterior with elastomeric sealant complying with Division 07 Section "Joint Sealants" to provide a watertight installation.
- G. Installing Cast-Iron Wheel Guards
1. Anchor wheel guards to concrete or masonry construction to comply with manufacturer's written instructions. Fill cores solidly with concrete.
- H. Installing Bearing And Leveling Plates
1. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
  2. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
    - a. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations unless otherwise indicated.
    - b. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.
- I. Adjusting And Cleaning
1. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
    - a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

**OR**

Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 07.
  2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05 05 19 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
05 05 19 00	01 22 16 00	No Specification Required

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## SECTION 05 05 23 00 - STRUCTURAL STEEL

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. Section Includes:
  - a. Structural steel.
  - b. Prefabricated building columns.
  - c. Grout.

#### C. Definitions

1. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
2. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.
3. Heavy Sections: Rolled and built-up sections as follows:
  - a. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches (38 mm).
  - b. Welded built-up members with plates thicker than 2 inches (50 mm).
  - c. Column base plates thicker than 2 inches (50 mm).
4. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.
5. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

#### D. Performance Requirements

1. Connections: Provide details of connections **OR** simple shear connections, **as directed**, required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering design by a qualified professional engineer, **as directed**, to withstand loads indicated and comply with other information and restrictions indicated.
  - a. Select and complete connections using schematic details indicated and AISC 360.
  - b. Use LRFD; data are given at factored-load level **OR** ASD; data are given at service-load level, **as directed**.
2. Moment Connections: Type PR, partially **OR** FR, fully, **as directed**, restrained.
3. Construction: Moment frame **OR** Braced frame **OR** Shear wall system **OR** Combined system of moment frame and braced frame **OR** Combined system of moment frame and shear walls **OR** Combined system of braced frame and shear walls **OR** Combined system of moment frame, braced frame, and shear walls, **as directed**.

#### E. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittal:
  - a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.



3. Shop Drawings: Show fabrication of structural-steel components.
  - a. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
  - b. Include embedment drawings.
  - c. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
  - d. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
  - e. Identify members and connections of the seismic-load-resisting system.
  - f. Indicate locations and dimensions of protected zones.
  - g. Identify demand critical welds.
  - h. For structural-steel connections indicated to comply with design loads, include structural design data signed and sealed by the qualified professional engineer responsible for their preparation, **as directed**.
4. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing **OR** qualified by testing, **as directed**, including the following:
  - a. Power source (constant current or constant voltage).
  - b. Electrode manufacturer and trade name, for demand critical welds.
5. Qualification Data: For qualified Installer **OR** fabricator **OR** professional engineer **OR** testing agency, **as directed**.
6. Welding certificates.
7. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
8. Mill test reports for structural steel, including chemical and physical properties.
9. Product Test Reports: For the following:
  - a. Bolts, nuts, and washers including mechanical properties and chemical analysis.
  - b. Direct-tension indicators.
  - c. Tension-control, high-strength bolt-nut-washer assemblies.
  - d. Shear stud connectors.
  - e. Shop primers.
  - f. Nonshrink grout.
10. Source quality-control reports.

#### F. Quality Assurance

1. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
2. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE **OR** CSE, **as directed**.
3. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 **OR** P2 **OR** P3, **as directed**, or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
4. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - a. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.
5. Comply with applicable provisions of the following specifications and documents:
  - a. AISC 303.
  - b. AISC 341 and AISC 341s1.
  - c. AISC 360.
  - d. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
6. Preinstallation Conference: Conduct conference at Project site.



#### G. Delivery, Storage, And Handling

1. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
  - a. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
2. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
  - a. Fasteners may be repackaged provided the Owner's testing and inspecting agency observes repackaging and seals containers.
  - b. Clean and relubricate bolts and nuts that become dry or rusty before use.
  - c. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

#### H. Coordination

1. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.
2. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

### 1.2 PRODUCTS

#### A. Structural-Steel Materials

1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 50, **as directed**, percent.  
**OR**  
Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:
  - a. W-Shapes: 60 percent.
  - b. Channels, Angles, M **OR** S, **as directed**, -Shapes: 60 percent.
  - c. Plate and Bar: 25 percent.
  - d. Cold-Formed Hollow Structural Sections: 25 percent.
  - e. Steel Pipe: 25 percent.
  - f. All Other Steel Materials: 25 percent.
2. W-Shapes: ASTM A 992/A 992M **OR** ASTM A 572/A 572M, Grade 50 (345) **OR** ASTM A 529/A 529M, Grade 50 (345) **OR** ASTM A 913/A 913M, Grade 50 (345), **as directed**.
3. Channels, Angles, M **OR** S, **as directed**, -Shapes: ASTM A 36/A 36M **OR** ASTM A 572/A 572M, Grade 50 (345) **OR** ASTM A 529/A 529M, Grade 50 (345) **OR** ASTM A 913/A 913M, Grade 50 (345), **as directed**.
4. Plate and Bar: ASTM A 36/A 36M **OR** ASTM A 572/A 572M, Grade 50 (345) **OR** ASTM A 529/A 529M, Grade 50 (345), **as directed**.
5. Corrosion-Resisting Structural-Steel Shapes, Plates, and Bars: ASTM A 588/A 588M, Grade 50 (345).
6. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B **OR** C, **as directed**, structural tubing.
7. Corrosion-Resisting Cold-Formed Hollow Structural Sections: ASTM A 847/A 847M, structural tubing.
8. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
  - a. Weight Class: Standard **OR** Extra strong **OR** Double-extra strong, **as directed**.
  - b. Finish: Black **OR** Galvanized **OR** Black except where indicated to be galvanized, **as directed**.



9. Steel Castings: ASTM A 216/A 216M, Grade WCB with supplementary requirement S11.
10. Steel Forgings: ASTM A 668/A 668M.
11. Welding Electrodes: Comply with AWS requirements.

B. Bolts, Connectors, And Anchors

1. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish.
  - a. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with plain finish.
2. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy-hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends, **as directed**; ASTM A 563, Grade DH, (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers with plain finish.
  - a. Direct-Tension Indicators: ASTM F 959, Type 490 (ASTM F 959M, Type 10.9), compressible-washer type with plain finish.
3. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers.
  - a. Finish: Hot-dip zinc coating **OR** Mechanically deposited zinc coating, **as directed**.
  - b. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with mechanically deposited zinc coating **OR** mechanically deposited zinc coating, baked epoxy-coated, **as directed**, finish.
4. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex **OR** round, **as directed**, head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
  - a. Finish: Plain **OR** Mechanically deposited zinc coating, **as directed**.
5. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
6. Unheaded Anchor Rods: ASTM F 1554, Grade 36 **OR** ASTM F 1554, Grade 55, weldable **OR** ASTM A 354 **OR** ASTM A 449 **OR** ASTM A 572/A 572M, Grade 50 (345) **OR** ASTM A 36/A 36M, **as directed**.
  - a. Configuration: Straight **OR** Hooked, **as directed**.
  - b. Nuts: ASTM A 563 (ASTM A 563M) hex **OR** heavy-hex, **as directed**, carbon steel.
  - c. Plate Washers: ASTM A 36/A 36M carbon steel.
  - d. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
  - e. Finish: Plain **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** Mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
7. Headed Anchor Rods: ASTM F 1554, Grade 36 **OR** ASTM F 1554, Grade 55, weldable **OR** ASTM A 354 **OR** ASTM A 449, **as directed**, straight.
  - a. Nuts: ASTM A 563 (ASTM A 563M) hex **OR** heavy-hex, **as directed**, carbon steel.
  - b. Plate Washers: ASTM A 36/A 36M carbon steel.
  - c. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
  - d. Finish: Plain **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** Mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
8. Threaded Rods: ASTM A 36/A 36M **OR** ASTM A 193/A 193M, Grade B7 **OR** ASTM A 354, Grade BD **OR** ASTM A 449 **OR** ASTM A 572/A 572M, Grade 50 (345), **as directed**.
  - a. Nuts: ASTM A 563 (ASTM A 563M) hex **OR** heavy-hex, **as directed**, carbon steel.
  - b. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened **OR** ASTM A 36/A 36M, **as directed**, carbon steel.
  - c. Finish: Plain **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** Mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
9. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.
10. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.



11. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.
  12. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint.
    - a. Mating Surfaces: PTFE and PTFE **OR** PTFE and mirror-finished stainless steel, **as directed**.
    - b. Coefficient of Friction: Not more than 0.03 **OR** 0.04 **OR** 0.05 **OR** 0.06 **OR** 0.10 **OR** 0.12, **as directed**.
    - c. Design Load: Not less than 2,000 psi (13.7 MPa) **OR** 5,000 psi (34 MPa) **OR** 6,000 psi (41 MPa), **as directed**.
    - d. Total Movement Capability: 2 inches (50 mm).
- C. Primer
1. Primer: Comply with Division 07 **OR** Division 09 Section(s) "High-performance Coatings" **OR** Division 07 **AND** Division 09 Section(s) "High-performance Coatings", **as directed**.  
**OR**  
Primer: SSPC-Paint 25, Type I **OR** Type II, **as directed**, zinc oxide, alkyd, linseed oil primer.  
**OR**  
Primer: SSPC-Paint 25 BCS, Type I **OR** Type II, **as directed**, zinc oxide, alkyd, linseed oil primer.  
**OR**  
Primer: SSPC-Paint 23, latex primer.  
**OR**  
Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat, **as directed**.
  2. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20 **OR** ASTM A 780, **as directed**.
- D. Grout
1. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
  2. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
- E. Fabrication
1. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
    - a. Camber structural-steel members where indicated.
    - b. Fabricate beams with rolling camber up.
    - c. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
    - d. Mark and match-mark materials for field assembly.
    - e. If shop priming is required, complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
  2. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
    - a. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
  3. Bolt Holes: Cut, drill, mechanically thermal cut, **as directed**, or punch standard bolt holes perpendicular to metal surfaces.
  4. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
  5. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning" **OR** SSPC-SP 2, "Hand Tool Cleaning" **OR** SSPC-SP 3, "Power Tool Cleaning", **as directed**.
  6. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.



7. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural steel. Straighten as required to provide uniform, square, and true members in completed wall framing.
  8. Welded Door Frames: Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches (250 mm) o.c. unless otherwise indicated.
  9. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
    - a. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning, **unless directed otherwise**.
    - b. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
    - c. Weld threaded nuts to framing and other specialty items indicated to receive other work.
- F. Shop Connections
1. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
    - a. Joint Type: Snug tightened **OR** Pretensioned **OR** Slip critical, **as directed**.
  2. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M, **as directed**, for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
    - a. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.
- G. Prefabricated Building Columns
1. Prefabricated building columns consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell.
  2. Fire-Resistance Ratings: Provide prefabricated building column listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing according to ASTM E 119.
    - a. Fire-Resistance Rating: 4 hours **OR** 3 hours **OR** 2 hours **OR** As indicated, **as directed**.
- H. Shop Priming
1. If shop priming is required, shop prime steel surfaces except the following:
    - a. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
    - b. Surfaces to be field welded.
    - c. Surfaces to be high-strength bolted with slip-critical connections.
    - d. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
    - e. Galvanized surfaces.
  2. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
    - a. SSPC-SP 2, "Hand Tool Cleaning."
    - b. SSPC-SP 3, "Power Tool Cleaning."
    - c. SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."
    - d. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
    - e. SSPC-SP 14/NACE No. 8, "Industrial Blast Cleaning."
    - f. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
    - g. SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."
    - h. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."
    - i. SSPC-SP 8, "Pickling."
  3. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5



mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

- a. Stripe paint corners, crevices, bolts, welds, and sharp edges.
  - b. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.
4. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).
- I. Galvanizing
1. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
    - a. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.
    - b. Galvanize lintels, shelf angles, and welded door frames attached to structural-steel frame and located in exterior walls.
- J. Source Quality Control
1. Testing Agency: Engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
    - a. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
  2. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
  3. Bolted Connections: Shop-bolted connections will be inspected **OR** tested and inspected, **as directed**, according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
  4. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
    - a. Liquid Penetrant Inspection: ASTM E 165.
    - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
    - c. Ultrasonic Inspection: ASTM E 164.
    - d. Radiographic Inspection: ASTM E 94.
  5. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
    - a. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
    - b. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.

### 1.3 EXECUTION

#### A. Examination

1. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
  - a. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### B. Preparation

1. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in



intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

- a. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

#### C. Erection

1. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
2. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
  - a. Set plates for structural members on wedges, shims, or setting nuts as required.
  - b. Weld plate washers to top of baseplate.
  - c. Snug-tighten **OR** Pretension, **as directed**, anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
  - d. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts, **as directed**.
3. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
4. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
  - a. Level and plumb individual members of structure.
  - b. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
5. Splice members only where indicated.
6. Do not use thermal cutting during erection unless approved by the Owner. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.
7. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
8. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

#### D. Field Connections

1. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
  - a. Joint Type: Snug tightened **OR** Pretensioned **OR** Slip critical, **as directed**.
2. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M, **as directed**, for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
  - a. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
  - b. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
  - c. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

#### E. Prefabricated Building Columns

1. Install prefabricated building columns to comply with AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.



F. Field Quality Control

1. Testing Agency: Engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
2. Bolted Connections: Bolted connections will be inspected **OR** tested and inspected, **as directed**, according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
3. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.
  - a. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
    - 1) Liquid Penetrant Inspection: ASTM E 165.
    - 2) Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
    - 3) Ultrasonic Inspection: ASTM E 164.
    - 4) Radiographic Inspection: ASTM E 94.
4. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
  - a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
  - b. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.
5. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

G. Repairs And Protection

1. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.
2. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
  - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

**OR**

Touchup Painting: Cleaning and touchup painting are specified in Division 07.

END OF SECTION 05 05 23 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
05 05 23 00	01 22 16 00	No Specification Required
05 05 23 00	05 05 19 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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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
05 12 23 00	05 05 23 00	Structural Steel
05 12 23 00	05 05 19 00	Metal Fabrications
05 13 00 00	05 05 19 00	Metal Fabrications



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## SECTION 05 14 16 00 - STRUCTURAL ALUMINUM

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Performance Requirements

1. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-aluminum fabricator to withstand loads indicated and comply with other information and restrictions indicated.
  - a. Select and complete connections using schematic details indicated and in accordance with minimum mechanical properties and applicable buckling formula constants published by The Aluminum Association's "Aluminum Construction Manual."

#### C. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: Show fabrication of structural-aluminum components.
3. Welding certificates.
4. Mill test reports.
5. Source quality-control test reports.

#### D. Quality Assurance

1. Fabricator Qualifications: A qualified fabricator who has provided successful structural aluminum fabrication for a minimum of 5 years.
2. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code--Aluminum."
3. Comply with applicable provisions of The Aluminum Association's "Aluminum Construction Manual."
4. Preinstallation Conference: Conduct conference at Project site.

### 1.2 PRODUCTS

#### A. Structural-Aluminum Materials

1. W-Shapes, Channels, Angles, Plate and Bar, Cold-Formed Hollow Structural Sections, and Pipe: Structural shapes indicating minimum mechanical properties and applicable buckling formula constants are listed in Table 3.3.1, Section 3, of "Specifications for Aluminum Structures," Construction Manual Series Section 1, as published by The Aluminum Association. Applicable ASTM Designations include B209, B210, B211, B221, B241, B247, B308, and B429
2. Allowable Stresses:
  - a. Building Type Structures: Basic allowable tensile stresses for buildings, structural supports for highway signs, luminaires, traffic signals and similar structures shall be the lesser of the minimum yield strength divided by a factor of safety of 1.65, or the minimum ultimate tensile strength divided by a factor of safety of 1.95. Other allowable stresses for buildings and similar structures shall be based upon the factors of safety shown in Table 3.3.3 of "Specifications for Aluminum Structures."
  - b. Bridge Type Structures: Basic allowable tensile stresses for bridge type structures shall be the lesser of the minimum yield strength divided by a factor of safety of 1.85, or the minimum ultimate tensile strength divided by a factor of safety of 2.2. Other allowable



stresses for bridge and similar structures shall be based upon the factors of safety shown in Table 3.3.3 of "Specifications for Aluminum Structures."

3. Welding Electrodes: Comply with AWS requirements.

#### B. Bolts and Connectors

1. Rivets and Bolts:
  - a. Aluminum alloys used for rivets and bolts shall be those listed in Tables 5.1.1b and 5.1.1c of "Specifications for Aluminum Structures."
  - b. Nuts:
    - 1) For bolts 1/4" and smaller: Alloy 2024-T4. For improved corrosion resistance, apply 0.0002" minimum thickness anodic coating.
    - 2) For bolts larger than 1/4": 6061-T6 or 6262-T9.
    - 3) Flat Washers: Alclad 2024-T4.
    - 4) Spring Lock Washers: Alloy 7075-T6.
  - c. Steel Bolts: Hot-dip galvanized, electro-galvanized, cadmium plated or aluminized steel bolts and Series 300 stainless steel bolts may be used instead of aluminum bolts. Plating thickness on steel shall be adequate to provide corrosion protection for the anticipated environ and service life.

#### C. Grout

1. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404, Size No. 2. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
2. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
3. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

#### D. Fabrication

1. Structural Aluminum: Fabricate and assemble in shop to greatest extent possible. Fabricate according to The Aluminum Association's "Aluminum Construction Manual."

#### E. Source Quality Control

1. Engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports. Comply with testing and inspection requirements of Part 1.3, Article "Field Quality Control."
2. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

### 1.3 EXECUTION

#### A. Erection

1. Examination: Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with erector present, for compliance with requirements.
  - a. Proceed with installation only after unsatisfactory conditions have been corrected.
2. Set structural aluminum accurately in locations and to elevations indicated and according to The Aluminum Association's "Aluminum Construction Manual."
3. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
  - a. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.



- b. Weld plate washers to top of base plate.
  - c. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
  - d. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
4. Maintain erection tolerances of structural aluminum within The Aluminum Association's "Aluminum Construction Manual."
- B. Field Connections
1. Bolts: Shop install bolts according to The Aluminum Association's "Aluminum Construction Manual" for type of bolt and type of joint specified.
  2. Weld Connections: Comply with AWS D1.2 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
    - a. Comply with The Aluminum Association's "Aluminum Construction Manual" for bearing, adequacy of temporary connections, and alignment.
- C. Field Quality Control
1. Testing Agency: Engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
  2. Bolted Connections: Shop-bolted connections shall be tested and inspected according to The Aluminum Association's "Aluminum Construction Manual."
  3. Welded Connections: Field welds shall be visually inspected according to AWS D1.2.
    - a. In addition to visual inspection, field welds shall be tested according to AWS D1.2.
  4. Correct deficiencies in Work that test reports and inspections indicate are not in compliance with the Contract Documents.

END OF SECTION 05 14 16 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
05 14 16 00	01 22 16 00	No Specification Required

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## SECTION 05 21 19 00 - STEEL JOISTS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for steel joists. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. K-series steel joists.
  - b. KCS-type K-series steel joists.
  - c. K-series steel joist substitutes.
  - d. Long-span steel joists.
  - e. Joist girders.
  - f. Joist accessories.

#### C. Definitions

1. SJI "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."
2. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

#### D. Performance Requirements

1. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.
2. Design special joists to withstand design loads with live load deflections no greater than the following:
  - a. Floor Joists: Vertical deflection of 1/360 **OR** 1/240, **as directed**, of the span.
  - b. Roof Joists: Vertical deflection of 1/360 **OR** 1/240, **as directed**, of the span.

#### E. Submittals

1. Product Data: For each type of joist, 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, designation, number, type, location, and spacings of joists. Include joining and anchorage details, bracing, bridging, joist accessories; splice and connection locations and details; and attachments to other construction.
4. Welding certificates.
5. Manufacturer Certificates
6. Mill Certificates: For bolts.
7. Field quality-control test and inspection reports.
8. Research/Evaluation Reports: For joists.

#### F. Quality Assurance

1. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables of SJI "Specifications."



- a. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.
2. SJI Specifications: Comply with standard specifications in SJI's "Specifications" that are applicable to types of joists indicated.
3. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

G. Delivery, Storage, And Handling

1. Deliver, store, and handle joists as recommended in SJI's "Specifications."
2. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

H. Sequencing

1. Deliver steel bearing plates to be built into cast-in-place concrete and masonry construction.

## 1.2 PRODUCTS

A. Materials

1. Steel: Comply with SJI's "Specifications" for web and steel-angle chord members.
  - a. Recycled Content: 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 **OR** 60, **as directed**, percent.
2. Steel Bearing Plates: ASTM A 36/A 36M.
3. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.
  - a. Finish: Plain, uncoated **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** Mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
4. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.
  - a. Finish: Plain, uncoated **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** Mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
5. Welding Electrodes: Comply with AWS standards.
6. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20 **OR** ASTM A 780, **as directed**.

B. Primers

1. Primer:
  - a. SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.  
**OR**  
Provide shop primer that complies with Division 07.

C. K-Series Steel Joists

1. Manufacture steel joists of type indicated according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.
  - a. Joist Type: K-series steel joists **OR** KCS-type K-series steel joists, **as directed**.
2. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.
3. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work.
4. Provide holes in chord members for connecting and securing other construction to joists.



5. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated, complying with SJI's "Specifications."
  6. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated, complying with SJI's "Specifications."
  7. Do not camber joists.
  8. Camber joists according to SJI's "Specifications," **OR** as indicated, **as directed**.
  9. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).
- D. Long-Span Steel Joists
1. Manufacture steel joists according to "Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements as follows **OR** as indicated, **as directed**.
    - a. Joist Type: LH-series steel joists **OR** DLH-series steel joists, **as directed**.
    - b. End Arrangement: Underslung **OR** Square, **as directed**.
    - c. Top-Chord Arrangement: Parallel **OR** Pitched 1/8 inch per 12 inches (1:96), 1 way **OR** Pitched 1/8 inch per 12 inches (1:96), 2 ways, **as directed**.
  2. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work.
  3. Provide holes in chord members for connecting and securing other construction to joists.
  4. Camber long-span steel joists according to SJI's "Specifications" **OR** as indicated, **as directed**.
  5. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).
- E. Joist Girders
1. Manufacture joist girders according to "Standard Specifications for Joist Girders" in SJI's "Specifications," with steel-angle top- and bottom-chord members; with end and top-chord arrangements as follows **OR** as indicated, **as directed**.
    - a. End Arrangement: Underslung **OR** Underslung with bottom-chord extensions **OR** Square, **as directed**.
    - b. Top-Chord Arrangement: Parallel **OR** Pitched 1/8 inch per 12 inches (1:96), 1 way **OR** Pitched 1/8 inch per 12 inches (1:96), 2 ways, **as directed**.
  2. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work.
  3. Provide holes in chord members for connecting and securing other construction to joist girders.
  4. Camber joist girders according to SJI's "Specifications" **OR** as indicated, **as directed**.
  5. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).
- F. Joist Accessories
1. Bridging: Provide bridging anchors and number of rows of horizontal **OR** diagonal, **as directed**, bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
  2. Bridging: Schematically indicated. Detail and fabricate according to SJI's "Specifications." Furnish additional erection bridging if required for stability.
  3. Bridging: Fabricate as indicated and according to SJI's "Specifications." Furnish additional erection bridging if required for stability.
  4. Fabricate steel bearing plates with integral anchorages of sizes and thicknesses indicated. Shop prime paint **OR** Hot-dip zinc coat according to ASTM A 123/A 123M, **as directed**.
  5. Supply ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction. Extend ends to within 1/2 inch (13 mm) of finished wall surface, unless otherwise indicated.
  6. Supply miscellaneous accessories, including splice plates and bolts required by joist manufacturer to complete joist installation.



G. Cleaning And Shop Painting

1. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 **OR** power-tool cleaning, SSPC-SP 3, **as directed**.
2. Do not prime paint joists and accessories to receive sprayed fire-resistive materials, **as directed**.
3. Apply 1 coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil (0.025 mm) thick.  
**OR**  
Shop priming of joists and joist accessories is specified in Division 07.

1.3 EXECUTION

A. Installation

1. Do not install joists until supporting construction is in place and secured.
2. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.
  - a. Before installation, splice joists delivered to Project site in more than one piece.
  - b. Space, adjust, and align joists accurately in location before permanently fastening.
  - c. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
  - d. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads have been applied.
3. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
4. Bolt joists to supporting steel framework using carbon-steel bolts.  
**OR**  
Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts" for high-strength structural bolt installation and tightening requirements.
5. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

B. Field Quality Control

1. Testing Agency: Engage a qualified independent testing and inspecting agency to inspect field welds and bolted connections and to perform field tests and inspections and prepare test and inspection reports.
2. Field welds will be visually inspected according to AWS D1.1/D1.1M.
3. In addition to visual inspection, field welds will be tested according to AWS D1.1/D1.1M and the following procedures, as applicable:
  - a. Radiographic Testing: ASTM E 94.
  - b. Magnetic Particle Inspection: ASTM E 709.
  - c. Ultrasonic Testing: ASTM E 164.
  - d. Liquid Penetrant Inspection: ASTM E 165.
4. Bolted connections will be visually inspected.
5. High-strength, field-bolted connections will be tested and verified according to procedures in RCSC's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts."
6. Correct deficiencies in Work that test and inspection reports have indicated are not in compliance with specified requirements.
7. Additional testing will be performed to determine compliance of corrected Work with specified requirements.

C. Repairs And Protection



1. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
2. Touchup Painting:
  - a. After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.
    - 1) Clean and prepare surfaces by hand-tool cleaning, SSPC-SP 2, or power-tool cleaning, SSPC-SP 3.
    - 2) Apply a compatible primer of same type as shop primer used on adjacent surfaces.
3. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that joists and accessories are without damage or deterioration at time of Final Completion.

END OF SECTION 05 21 19 00



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## SECTION 05 31 00 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.



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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 00 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
05 36 00 00	05 31 00 00	Steel Deck
05 41 00 00	05 12 23 00	Cold-Formed Metal Framing
05 42 33 00	05 12 23 00	Cold-Formed Metal Framing
05 43 00 00	01 22 16 00	No Specification Required
05 43 00 00	05 12 23 00	Cold-Formed Metal Framing
05 43 00 00	05 05 19 00	Metal Fabrications



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## SECTION 05 73 00 00 - ORNAMENTAL METAL

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. Section Includes:
  - a. Decorative window security bars.
  - b. Decorative mechanical grilles and frames.
  - c. Decorative-metal-clad, hollow-metal doors and frames.
  - d. Custom door pulls.
  - e. Combination hall push-button stations.
  - f. Metal reveals at wood paneling.
  - g. Cast-metal rosettes at marble joints.

#### C. Submittals

1. Product Data: For each type of product indicated, including finishing materials.
2. LEED Submittals:
  - a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Show fabrication and installation details for decorative metal.
  - a. Include plans, elevations, component details, and attachments to other work.
  - b. Indicate materials and profiles of each decorative metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.
4. Patterns, Models, or Plaster Castings: Made from proposed patterns for each design of custom casting required.
5. Samples: For each type of exposed finish required.
  - a. Sections of linear shapes.
  - b. Full-size Samples of castings and forgings.
    - 1) For custom castings, submit finished Samples showing ability to reproduce detail, cast-metal color, and quality of finish. Samples may be of similar previous work.
  - c. Samples of welded and brazed joints showing quality of workmanship and color matching of materials.
6. Qualification Data: For qualified fabricator **OR** organic-coating applicator **OR** anodic finisher **OR** powder-coating applicator, **as directed**.
7. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.
8. Welding certificates.

#### D. Quality Assurance

1. Fabricator Qualifications: A firm experienced in producing decorative metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
2. Installer Qualifications: Fabricator of products.



3. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings, of type indicated, to aluminum extrusions and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
4. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
5. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
6. Welding Qualifications: Qualify procedures and personnel according to the following:
  - a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
  - c. AWS D1.3, "Structural Welding Code - Sheet Steel."
  - d. AWS D1.6, "Structural Welding Code - Stainless Steel."
7. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling

1. Store decorative metal in a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.
2. Deliver and store cast-metal products in wooden crates surrounded by sufficient packing material to ensure that products will not be cracked or otherwise damaged.

F. Project Conditions

1. Field Measurements: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.

G. Coordination

1. Coordinate installation of anchorages for decorative metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

## 1.2 PRODUCTS

A. Metals, General

1. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. Provide materials without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Aluminum

1. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
  - a. Extruded Bars and Shapes: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.
  - b. Extruded Structural Pipe and Round Tubing: ASTM B 429/B 429M, Alloy 6063-T6.
  - c. Drawn Seamless Tubing: ASTM B 210 (ASTM B 210M) or ASTM B 483/B 483M, Alloy 6063-T832.
  - d. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003-H14 **OR** Alloy 5005-H32 **OR** Alloy 6061-T6, **as directed**.
  - e. Die and Hand Forgings: ASTM B 247 (ASTM B 247M), Alloy 6061-T6.
  - f. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

C. Copper Alloys



1. Copper and Copper Alloys, General: Provide alloys indicated and temper to suit application and forming methods but with strength and stiffness not less than H01 (quarter-hard) for plate, sheet, strip, and bars and H55 (light-drawn) for tube and pipe.
  2. Extruded Shapes, Bronze: ASTM B 455, Alloy UNS No. C38500 (architectural bronze).
  3. Extruded Shapes, Brass: ASTM B 249/B 249M, Alloy UNS No. C36000 (free-cutting brass).
  4. Extruded Shapes, Nickel Silver: ASTM B 249/B 249M, Alloy UNS No. C79600.
  5. Seamless Pipe, Bronze: ASTM B 43, Alloy UNS No. C23000 (red brass, 85 percent copper).
  6. Seamless Tube, Bronze: ASTM B 135 (ASTM B 135M), Alloy UNS No. C23000 (red brass, 85 percent copper).
  7. Seamless Tube, Brass: ASTM B 135 (ASTM B 135M), Alloy UNS No. C26000 (cartridge brass, 70 percent copper).
  8. Seamless Tube, Copper: ASTM B 75 (ASTM B 75M), Alloy UNS No. C12200 (phosphorous deoxidized, high residual phosphorous copper).
  9. Castings, Bronze: ASTM B 62, Alloy UNS No. C83600 (85-5-5-5 or No. 1 composition commercial red brass) or ASTM B 584, Alloy UNS No. C86500 (No. 1 manganese bronze).
  10. Castings, Brass: ASTM B 584, Alloy UNS No. C85200 (high-copper yellow brass).
  11. Castings, Copper: ASTM B 824, with a minimum of 99.9 percent copper.
  12. Castings, Nickel Silver: ASTM B 584, Alloy UNS No. C97300 (12 percent leaded nickel silver).
  13. Plate, Sheet, Strip, and Bars; Bronze: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper).
  14. Plate, Sheet, Strip, and Bars; Brass: ASTM B 36/B 36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper).
  15. Plate, Sheet, Strip, and Bars; Copper: ASTM B 152/B 152M, Alloy UNS No. C11000 (electrolytic tough pitch copper) or UNS No. C12200 (phosphorous deoxidized, high-residual phosphorous copper).
- D. Stainless Steel
1. Tubing: ASTM A 554, Grade MT 304 **OR** Grade MT 316 **OR** Grade MT 316L, **as directed**.
  2. Pipe: ASTM A 312/A 312M, Grade TP 304 **OR** Grade TP 316 **OR** Grade TP 316L, **as directed**.
  3. Castings: ASTM A 743/A 743M, Grade CF 8 or CF 20 **OR** Grade CF 8M or CF 3M, **as directed**.
  4. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 304 **OR** Type 316 **OR** Type 316L, **as directed**.
  5. Bars and Shapes: ASTM A 276, Type 304 **OR** Type 316 **OR** Type 316L, **as directed**.
  6. Wire Rope and Fittings:
    - a. Wire Rope: 1-by-19 **OR** 7-by-7 **OR** 7-by-19, **as directed**, wire rope made from wire complying with ASTM A 492, Type 316.
    - b. Wire-Rope Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.
- E. Steel And Iron
1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
  2. Tubing: ASTM A 500 (cold formed) or ASTM A 513, Type 5 (mandrel drawn).
  3. Bars: Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.
  4. Plates, Shapes, and Bars: ASTM A 36/A 36M.
  5. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M unless otherwise indicated.
  6. Steel Sheet, Cold Rolled: ASTM A 1008/A 1008M, either commercial steel or structural steel, exposed.
- F. Titanium
1. Titanium Strip, Sheet, and Plate: ASTM B 265, Grade 1.
  2. Titanium Bars: ASTM B 348, Grade 1.



## G. Fasteners

1. Fastener Materials: Unless otherwise indicated, provide the following:
  - a. Aluminum Items: Aluminum **OR** Type 304 stainless-steel **OR** Type 316 stainless-steel, **as directed**, fasteners.
  - b. Copper-Alloy (Bronze) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners where concealed, muntz metal (Alloy 280) fasteners where exposed.
  - c. Copper-Alloy (Brass) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners where concealed, brass (Alloy 260 or 360) fasteners where exposed.
  - d. Stainless-Steel Items: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
  - e. Titanium Items: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
  - f. Uncoated-Steel Items: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed, Type 304 stainless-steel fasteners where exposed.
  - g. Galvanized-Steel Items: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
  - h. Dissimilar Metals: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
2. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.
3. Provide concealed fasteners for interconnecting components and for attaching decorative metal items to other work unless otherwise indicated **OR** exposed fasteners are unavoidable, **as directed**.
  - a. Provide Phillips **OR** tamper-resistant **OR** square or hex socket, **as directed**, flat-head machine screws for exposed fasteners unless otherwise indicated.
4. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
5. Post-Installed Anchors: Torque-controlled expansion type or chemical type.
  - a. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 unless otherwise indicated.
  - b. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**, stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

## H. Miscellaneous Materials

1. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
  - a. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
2. Brazing Rods: For copper alloys, provide type and alloy as recommended by producer of metal to be brazed and as required for color match, strength, and compatibility in fabricated items.
3. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
4. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
5. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.
6. Shop Primers: Provide primers that comply with Division 07 **OR** Division 09 Section(s) "High-performance Coatings", **as directed**.
7. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
  - a. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
8. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.



9. Shop Primer for Galvanized Steel: Cementitious galvanized metal primer complying with MPI#26 **OR** Vinyl wash primer complying with MPI#80 **OR** Water-based galvanized metal primer complying with MPI#134, **as directed**.
10. Intermediate Coats and Topcoats for Steel: Provide products that comply with Division 07 **OR** Division 09 Section(s) "High-performance Coatings" **OR** Division 07 **AND** Division 09 Section(s) "High-performance Coatings", **as directed**.
11. Epoxy Intermediate Coat for Steel: Complying with MPI#77 and compatible with primer and topcoat.
12. Polyurethane Topcoat for Steel: Complying with MPI#72 and compatible with undercoat.
13. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

I. Fabrication, General

1. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
2. Make up wire-rope assemblies in the shop to field-measured dimensions with fittings machine swaged. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.
3. Form decorative metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.
4. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.
5. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.
6. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
7. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.
8. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
9. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.
10. Comply with AWS for recommended practices in shop welding and brazing. Weld and braze behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.
  - a. Where welding and brazing cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 Welds: no evidence of a welded joint **OR** Type 2 Welds: completely sanded joint, some undercutting and pinholes okay **OR** Type 3 Welds: partially dressed weld with spatter removed **OR** Type 4 Welds: good quality, uniform undressed weld with minimal splatter, **as directed**.
11. Provide castings that are sound and free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

J. Decorative Window Security Bars

1. General: Fabricate decorative window grilles to designs indicated from steel bars and shapes of sizes and profiles indicated. Form steel bars by bending, forging, coping, mitering, and welding.
2. Welding: Interconnect grille members with full-length, full-penetration welds unless otherwise indicated. Use welding method that is appropriate for metal and finish indicated and that



develops full strength of members joined. Finish exposed welds and surfaces smooth, flush, and blended to match adjoining surfaces.

3. Brackets, Fittings, and Anchors: Provide wall brackets, fittings, and anchors to connect decorative window grilles to other work unless otherwise indicated.
  - a. Furnish inserts and other anchorage devices to connect decorative window grilles to concrete and masonry work. Coordinate anchorage devices with supporting structure.
  - b. Fabricate anchorage devices that are capable of withstanding loads indicated.

#### K. Decorative Mechanical Grilles

1. Fabricate decorative grilles from perforated aluminum **OR** brass **OR** bronze **OR** stainless-steel **OR** steel, **as directed**, sheet or plate of thickness, size, and pattern indicated. Form perforations by punching, cutting, or drilling to produce openings of sizes and shapes indicated. Roll, press, and grind perforated metal to flatten and to remove burrs and deformations.
  - a. Form perforations to match existing grilles.  
**OR**  
Drawings indicate perforated metal patterns required and are based on products of one manufacturer. Perforated metal patterns produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as judged solely by the Owner.
2. Drill and countersink grilles for mounting screws at 2 inches (50 mm) from corners and at 10 inches (250 mm) or less o.c. Provide units with oval-head wood **OR** self-tapping machine, **as directed**, screws.
3. Fabricate grille frames from extruded aluminum **OR** brass **OR** bronze, **as directed**, of profiles, and to sizes and shapes indicated. Miter frame members at corners and connect with concealed splice plates welded **OR** brazed, **as directed**, to back of frames.
  - a. Secure grilles in frames with 0.5-inch- (12-mm-) long welds **OR** brazing, **as directed**, along perimeter of grilles at 4 inches (100 mm) o.c.
  - b. Provide frame profiles to match existing frames.  
**OR**  
Drawings indicate frame profiles required and are based on products of one manufacturer. Similar frame profiles produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as judged solely by the Owner.
4. Drill and countersink frames for mounting screws at 4 inches (100 mm) from corners and at 16 inches (400 mm) or less o.c. Provide units with oval-head wood **OR** self-tapping machine, **as directed**, screws.

#### L. Decorative-Metal-Clad Doors And Frames

1. Laminate 0.0403-inch- (1.0-mm-) thick, muntz-metal **OR** 0.0403-inch- (1.0-mm-) thick, brass **OR** 0.0375-inch- (0.95-mm-) thick, stainless-steel **OR** 0.024-inch- (0.6-mm-) thick, titanium, **as directed**, sheets to outside face of hollow-metal doors and frames at locations and to comply with details indicated. Use adhesive recommended by metal fabricator that will fully bond metal to metal and that will prevent telegraphing and oil canning.
  - a. Hollow-metal doors and frames are specified in Division 8 Section "Steel Doors and Frames."

#### M. Custom Door Pulls

1. Fabricate custom door pulls from brass **OR** bronze **OR** stainless-steel, **as directed**, bar stock of profile indicated, fabricated to shapes indicated. Form curves by bending to produce uniform curvature of radii indicated; maintain profile of member throughout entire bend without buckling, twisting, or otherwise deforming exposed surfaces. Where radii of bends are too small to avoid buckling, grind bars after bending to restore original profile. Drill and tap door pulls to receive through bolts for attachment to doors.
2. Fabricate backing plates for custom door pulls from 1/8-inch (3.2-mm) brass **OR** bronze **OR** stainless-steel, **as directed**, sheet. Cut to shape indicated and bevel edges at a 45-degree angle for one-half thickness of metal. Drill and countersink holes where indicated for screws and bolts.



3. Provide units with oval-head through bolts for mounting pulls and with oval-head wood screws for mounting backing plates.
- N. Combination Hall Push-Button Stations
1. Fabricate units of brass **OR** bronze **OR** stainless steel, **as directed**, to comply with details indicated. Coordinate with requirements in Division 14 Section "Electric Traction Elevators" to provide integrated, closely fitted assemblies.
    - a. Fabricate faceplates from 1/8-inch- (3.2-mm-) thick sheet with edges beveled at a 45-degree angle for one-half thickness of metal.
    - b. Provide units with rectangular, split-bowl trash receptacle, designed for recess mounting in nominal 4-inch (100-mm) wall depth. Fabricate recessed cabinets, top rings, and split bowls of same metal as face of units; fabricate removable receptacles of drawn aluminum. Nominal dimensions of units are 10 by 10 by 3-1/2 inches (250 by 250 by 90 mm) in depth.
    - c. Provide units with emergency pictorial signs and text, complying with requirements of authorities having jurisdiction, indicating that in fire emergency, elevators should not be used and that stairways should be used instead. Engrave pictorial sign and text into front surface of faceplates to a depth of 1/16 inch (1.6 mm) with engraving painted red. Make signs 5 inches (125 mm) wide by 8 inches (200 mm) high.
    - d. Provide cutouts in faceplates of units for push buttons of elevator hall push-button station, card reader, **as directed**, and elevator key switches. Coordinate locations and sizes of cutouts so additional faceplate is not required and so faces of push buttons are flush with fronts of faceplates and key switches project beyond faceplate only by depth of bezel.
- O. Metal Reveals
1. Fabricate metal reveals for wood paneling from 3/4-by-3/4-by-1/16-inch (19-by-19-by-3-mm) extruded-bronze **OR** 3/4-by-3/4-by-0.025-inch (19-by-19-by-0.6-mm) brake-formed, stainless-steel **OR** 3/4-by-3/4-by-0.015-inch (19-by-19-by-0.4-mm) brake-formed titanium, **as directed**, channels. Drill for mounting screws 6 inches (150 mm) from ends of channels and not more than 24 inches (600 mm) o.c. Locate mounting screws at same heights for all channels. Provide black-finished, **as directed**, hex-socket, wafer-head screws for mounting reveals.
- P. Cast-Metal Rosettes
1. Fabricate cast-metal rosettes to design indicated from aluminum **OR** brass **OR** bronze **OR** nickel silver, **as directed**. Drill and tap castings for threaded mounting studs.
    - a. Provide custom castings to match design indicated.
    - b. Manufacturer's stock castings may be considered, provided deviations are minor and do not change design concept as judged solely by the Owner.
    - c. Drawings indicate cast-metal rosette designs required and are based on products of one manufacturer. Castings produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as judged solely by the Owner.
- Q. Finishes, General
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- R. Aluminum Finishes
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
  2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
  3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.



- a. Color: Champagne **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.
4. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
  - a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
5. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
  - a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

**OR**

High-Performance Organic Finish: Three **OR** Four, **as directed**, -coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

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

## S. Copper-Alloy Finishes

1. Finish designations for copper alloys comply with the system established for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
2. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).
3. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).
4. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).
5. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).
6. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear organic, air drying, as specified below):
  - a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
7. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear organic, air drying, as specified below):
  - a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
8. Medium-Satin Finish, Lacquered: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below):
  - a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
9. Fine-Matte Finish, Lacquered: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear organic, air drying, as specified below):



- a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
  10. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide), with color matching the Owner's sample.
  11. Patina Conversion Coating: M36-C12-C52 (Mechanical Finish: directionally textured, uniform; Chemical Finish: nonetched cleaned, degreased; Chemical Finish: conversion coating, ammonium sulfate), with color matching the Owner's sample.
  12. Statuary Conversion Coating, Bright Relieved and Lacquered: M12-C55-M2x-O6x (Mechanical Finish: matte finish, as cast; Chemical Finish: conversion coating, sulfide; Mechanical Finish: buffed, as specified; Coating: clear, organic, air drying, as specified below), with color matching the Owner's sample:
    - a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
  13. Blackened, Bright Relieved, and Lacquered: M33-O60-M2x-O6x (Mechanical Finish: directionally textured, coarse satin; Coating: black, air drying; Mechanical Finish: buffed, as specified; Coating: clear, organic, air drying, as specified below), with blackening and buffing matching the Owner's sample:
    - a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
- T. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
  2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
    - a. Run grain of directional finishes with long dimension of each piece.
  3. Bright, Cold-Rolled, Unpolished Finish: No. 2B.
  4. Directional Satin Finish: No. 4.
  5. Dull Satin Finish: No. 6.
  6. Reflective, Directional Polish: No. 7.
  7. Mirrorlike Reflective, Nondirectional Polish: No. 8.
  8. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
  9. Sputter-Coated Finish: Titanium nitride coating deposited by magnetic sputter-coating process over indicated mechanical finish.
  10. Colored, Oxide-Film Finish: Clear, oxide interference film produced by degreasing and then immersing in a mixture of chromic and sulfuric acids.
    - a. Product: Subject to compliance with requirements, provide INCO colored stainless-steel finish as developed and licensed by International Nickel Co., Ltd.
    - b. Color: Match the Owner's sample **OR** As selected from finisher's full range, **as directed**.
- U. Steel And Iron Finishes
1. Galvanizing: Hot-dip galvanize products made from rolled, pressed, and forged steel shapes, castings, plates, bars, and strips indicated to be galvanized to comply with ASTM A 123/A 123M.
    - a. Hot-dip galvanize steel and iron hardware indicated to be galvanized to comply with ASTM A 153/A 153M.
    - b. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
    - c. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
  2. Preparing Galvanized Items for Shop Priming: After galvanizing, thoroughly clean decorative metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.



3. Preparing Nongalvanized Items for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" **OR** SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning" **OR** requirements indicated below, **as directed**:
  - a. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - b. Interiors (SSPC Zone 1A): SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
4. Primer Application: Apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
  - a. Shop prime uncoated ferrous-metal surfaces with universal shop primer **OR** primers specified in Division 07, **as directed**, unless zinc-rich primer is **OR** primers specified in Division 09 Section "High-performance Coatings" are, **as directed**, indicated.
  - b. Do not apply primer to galvanized surfaces.
5. Shop-Painted Finish: Comply with Division 09 Section(s) "Exterior Painting" **OR** "High-performance Coatings", **as directed**.
  - a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.
  - a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
7. Powder-Coat Finish: Prepare, treat, and coat nongalvanized ferrous metal to comply with resin manufacturer's written instructions and as follows:
  - a. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - b. Treat prepared metal with iron-phosphate pretreatment, rinse, and seal surfaces.
  - c. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm).
  - d. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
8. Powder-Coat Finish: Prepare, treat, and coat galvanized metal to comply with resin manufacturer's written instructions and as follows:
  - a. Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
  - b. Treat prepared metal with zinc-phosphate pretreatment, rinse, and seal surfaces.
  - c. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm).
  - d. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

#### V. Titanium Finishes

1. General: Fabricate items from finished titanium stock, taking care not to damage finish during fabrication. Protect finish as needed during fabrication by applying a strippable, temporary protective covering.
2. Dull Matte Finish: Pickled and annealed.
3. Bright Matte Finish: Vacuum annealed.

### 1.3 EXECUTION

#### A. Examination

1. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative metal.



2. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Installation, General
1. Provide anchorage devices and fasteners where needed to secure decorative metal to in-place construction.
  2. Perform cutting, drilling, and fitting required to install decorative metal. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.
  3. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.
  4. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.
  5. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.
  6. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.
    - a. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.
  7. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding and requirements for welding and for finishing welded connections in "Fabrication, General" Article. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
  8. Field Brazing: Comply with requirements for brazing and for finishing brazed connections in "Fabrication, General" Article. Braze connections that are not to be left as exposed joints but cannot be shop brazed because of shipping size limitations.
  9. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- C. Installing Decorative Window Security Bars
1. Fasten security bar frames to concrete and masonry walls with cast-in-place or postinstalled anchors. Peen exposed threads of anchors to prevent removal of security bars.
- D. Installing Decorative Mechanical Grilles
1. Mount decorative grilles at heights and in positions indicated, adjusting ductwork to be centered on grilles if any.
    - a. Secure to framing and blocking with specified fasteners.
    - b. On marble, brick, and other solid surfaces, secure with wood screws in lead plugs.
- E. Installing Decorative-Metal-Clad, Hollow-Metal Doors And Frames
1. Install doors and frames to comply with requirements specified in Division 08 Section "Hollow Metal Doors And Frames".
- F. Installing Custom Door Pulls
1. Install door pulls at heights and locations shown. Install with backing plates on both sides of doors. Fasten backing plates to doors with oval-head wood **OR** self-tapping metal, **as directed**, screws and secure pulls through doors and backing plates with oval-head machine screws.
- G. Installing Combination Hall Push-Button Stations
1. Coordinate installation of combination hall push-button stations with installation of related elevator signal equipment components specified in Division 14 Section "Electric Traction Elevators". Secure units in place with faceplate overlapping surrounding wall finish and drawn into contact with surrounding wall finish at entire perimeter of faceplate.



- H. Installing Metal Reveals At Wood Paneling
1. Install metal reveals between wood panels as paneling is installed. Secure to wood grounds with specified screws.
- I. Installing Cast-Metal Rosettes At Marble Joints
1. Install cast-metal rosettes at intersections of marble joints where indicated. Install only after marble work is complete and joints are grouted. Secure to wall by drilling a 3/4-inch- (19-mm-) round hole at intersection of marble joints and by filling hole with molding plaster into which threaded stud is embedded. Angle drill and rotate so bottom of hole is larger than at surface.
    - a. Secure rosettes in place with masking tape until plaster sets. After plaster has set, remove masking tape and adhesive residue.
- J. Cleaning And Protection
1. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.
  2. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.
  3. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
    - a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

**OR**

Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
  4. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
  5. Protect finishes of decorative metal from damage during construction period with temporary protective coverings approved by decorative metal fabricator. Remove protective covering at time of Final Completion.
  6. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 73 00 00

**SECTION 05 73 00 00a - MISCELLANEOUS ORNAMENTAL METALS****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of Trap Pit Doors; Access to Pipe Trenches; Subway Type Gratings; Manhole, Catch and Retention Basins, Hoods; Iron Fences and Railways, Wicket Guard and Fence; Pipe Railings; Chimney Caps; Cast Iron Sills; Expansion Joints; Chimney Cleanout Doors; Ladders; Ladder Rungs; Retractable Ladders and Balconies, Staircases and Counter-Balanced Stairs; Vent Back Frames in Exhaust Opening of Toilet Rooms; Grilles in Exhaust Openings in Toilet Rooms; Access Doors, Dressing Compartment Seat Frames; Stainless Steel; Lumber Rack; Ganging Rods; Auditorium Loudspeaker Grilles; Bronze Saddles (Exterior), Bronze Expansion Saddles (Interior); Bronze Pipe and Tubes; Aluminum Hat and Coat Racks and Hook Strips; Aluminum Angles for Showers; Aluminum Railings; Miscellaneous Ornamental Metal Work; Hardware.

**B. Submittals/Shop Drawings**

1. Show all locations, markings, quantities, materials, sizes and shapes.
2. Indicate all methods of connecting, anchoring, fastening, bracing and attaching work of other trades.
3. Do not fabricate until approval of Shop Drawing.
4. Product Design Data: For each type of product indicated in 1.2.

**C. Quality Assurance**

1. Retractable Ladders, Balconies, and Staircases: For use as a supplemental escape device up to 30 feet (9144 mm), comply with requirements of:
  - a. Underwriters Laboratories Inc. for use as a supplementary means of egress; provide UL listing data.
  - b. ICC International Building Code.
  - c. ICC International Fire Code.
2. For use as a mechanical equipment ladder, comply with requirements of ICC International Mechanical Code.
3. Provide Evaluation Reports showing compliance.

**D. Product Handling**

1. Before shipment to the job, all finished shall be adequately protected for transporting and erecting periods.
2. Replace damaged items with the approval of the Owner and at no additional cost to the Owner.

**1.2 PRODUCTS****A. Frame and Covers**

1. Aluminum: ASTM B 221, 6063-T6.
2. Bronze: ASTM B 455, Alloy C 38500.
3. Stainless Steel: ASTM A 167, Type 304.

**B. Gratings**

1. Aluminum Grating, Banding, and Kick Plate: Rectangular, pressure-locked bearing bars, ASTM B 221, 6063-T6, mill finish.
2. Steel Grating:
3. Grating: Rectangular, welded, ASTM A 569.
4. Bands and Kick Plate: ASTM A 36.
5. Finish: Galvanized, ASTM A 386, or painted with fabricator's standard shop primer.



- C. Castings (Frames, Covers, Steps, and Sills)
1. Gray Iron: ASTM A 48, Class 30. Malleable Iron, ASTM A 47.
  2. Steel: ASTM A 36; Galvanized, ASTM A 386.
  3. Aluminum: ASTM B 26, 356-T6.
  4. Stainless Steel: ASTM A 743, Grade CF8 or CF20
  5. Bronze: ASTM B 455, Alloy C38500 and ASTM B 135, Alloy C2800.
  6. Corner Protection: Steel angles with anchors, ASTM A 36; Galvanized, ASTM A 386.
  7. Ventilation Boxes: Extruded Aluminum, ASTM B 221, 6063-T6.
- D. Pipe and Tube Railings and Ladders
1. Post and rails: Steel pipe, ASTM A 53, Type E or S, Grade B, Schedule 40.
  2. Bars and Rungs: ASTM A 36.
  3. Finish: Galvanized, ASTM A 386 or shop primer, Fed. Spec. TT-P-86, Type I or II; TT-P-615, Type I, II, or V; TT-P-645.
  4. Aluminum: ASTM B 221, 6063-T6, T-52.
  5. Steel: ASTM A 36, A 500, A 501.
  6. Stainless Steel: ASTM A 544, Grade MT304; ASTM A 312, Grade TP304; ASTM A 167, Type 304.
- E. Retractable Ladders and Balconies
1. Ladders
    - a. Maintenance-free, aluminum and stainless steel construction.
    - b. Rungs: Extruded aluminum, 6005-T5 and 6005-T6 alloy.
    - c. Stiles: Extruded aluminum, 6063-T6 alloy.
    - d. Support 1,000 pounds (454 kg) per rung individually and 200 pounds per 6 feet (90 kg per 1.83 m) of length simultaneously.
    - e. Ground support of gravity loads; building wall support for lateral stability.
    - f. Provide deployment handle at each access level.
    - g. Provide removable deployment handle at lower access point; provide locking hub and padlock.
    - h. Provide dual safety rails at ladders with access from both sides.
    - i. Provide reinforcement channel where ladders extend beyond wall support, such as at parapets and roof tops, or where ladder spans open areas in excess of 5 feet (1524 mm) between attachment points.
    - j. Height: As directed.
  2. Balconies
    - a. Aluminum, 6063-T6 alloy.
    - b. Provide aluminum access balconies at locations as directed.
    - c. Size: As directed.
    - d. Railing: 42-inch (1,067 mm) rail 2 sides, restraining chain 1 side.
    - e. Platform Capacity: 100 pounds per square foot (488 kg/square m), unless directed otherwise.
    - f. Railing Capacity: Uniform load of not less than 50 pounds per lineal foot (74.5 kg per lineal m), unless directed otherwise.
    - g. Balustrade: Not less than 36 inches (914 mm) high.
    - h. Pickets and Rails: Configured not to pass a sphere 4 inches (100 mm) in diameter. Exception; triangular openings formed by riser, tread, and rail, configured not to pass a sphere 6 inches (150 mm) in diameter.
  3. Factory Finish: Clear anodized **OR** Manufacturer's standard shop-applied enamel **OR** As selected from manufacturer's standard colors **OR** Match paint sample supplied by the Owner, **as directed**.
- F. Staircases and Counter-Balanced Stairs
1. Provide aluminum staircases, platforms, and counter-balanced stairs at locations indicated on the drawings.
  2. Platform Capacity: 100 pounds per square foot (488 kg/square m), unless directed otherwise.



3. Railing Capacity: Uniform load of not less than 50 pounds per lineal foot (74.5 kg per lineal m), unless directed otherwise.
4. Required Width: Minimum 36 inches (914 mm).
5. Stair Rise: 4 inches (102 mm) minimum, 10 inches (254 mm) maximum.
6. Treads: 10 inches (254 mm) in depth.
7. Balustrade: Not less than 36 inches (914 mm) high.
8. Pickets and Rails: Configured not to pass a sphere 4 inches (101.6 mm) in diameter.
  - a. Exception: Triangular openings formed by riser, tread, and rail configured not to pass a sphere 6 inches (152.4 mm) in diameter.
  - b. Rail Projection: 3-1/2 inches (89 mm) maximum from each side of stairway into required width.

### 1.3 EXECUTION

#### A. Trap Pit Doors

1. Furnish and set trap pit doors and frames flush with the finish floors, pavement, grade or as otherwise required. Doors for interior pits shall be of 1/4 inch checkered steel plate set in angle frames having mitered and welded corners and angle seat for covers, provided with bronze lifting handles. Doors and frames for exterior pits shall be of cast iron and hinged with 3-1/2 x 5 inch extra heavy bronze hinges. All doors shall be provided with locking devices.

#### B. Access to Pipe Trenches

1. Checkered or flat steel plate access doors to pipe trenches below cellar floors shall be made in accordance with detail. Include angle iron frame, anchors, hardware, etc., complete. The steel plate access doors shall be flush with the adjoining floors. Hinges shall be approved bronze flush type. Provide bronze lift handle and approved locking device for each access door.
2. Doors shall be covered with resilient tile where required. Where cement floors occur, top of steel cover shall be flush, but depressed for other finishes as required by the thickness of floor finish.  
**See other Sections of Specifications for Finish.**
3. All doors under this section unless otherwise specified, shall be secured in place with bronze square shank locking device and brass deck plate with slot and socket holes. Furnish six (6) wrenches for brass deck plates for each different size of locking device.

#### C. Manhole, Catch and Retention Basins, Hoods

1. Furnish cast iron manhole covers, catch basin covers and cast iron hoods for masonry, manholes, catch basins and retention basins furnished and installed under Division 22 OR Division 28.
2. Manhole covers and frames for catch basins shall be of cast iron, with locking device and key, equal to Flockhart Company No. 35-139.
3. Covers and frames for catch basins shall be of cast iron, with locking device and key, equal to Flockhart Company No. 35-328.
4. Covers and frames for catch basins shall be of cast iron, with locking device and key, equal to Flockhart Company No. 18-919.
5. Cast iron hoods for catch basins and manhole shall be equal to Flockhart Company pattern number indicated.

#### D. Iron Fences and Railings

1. Furnish and erect iron railings, fences, and gates. Materials of fences and railings shall be medium steel, shapes as required.
2. Posts and braces shall be leaded into cast-iron shoes, which shall be embedded in the concrete pavements or blocks. Center picket of each panel of 6 foot fence shall be leaded 2 inches into curb or pavement. Fences and railings on stone copings, platforms, steps or check blocks shall be leaded into sockets cut in same. Gates shall be hung with hinges. Provide all hasps required for locking gates in both open and closed positions. Double and quadruple gates shall also be furnished with sliding lever bolts and galvanized, malleable iron catches having pipe anchor and



drain embedded in concrete. Gates shall be locked open or closed with Type C Padlocks. Rivet the padlocks to the gates as required. Single gates require 1 padlock; double gates, 2 padlocks; quadruple gates, 4 padlocks.

3. Furnish cast-iron shoes for fence posts and set them at the proper time so that they may be cast into the concrete footing and pavements with top flush with finished surfaces.
4. Folding swing gates shall have fast pin to hold in closed position.
5. Unless otherwise required center rails and side rails on outside steps shall be made of 1-1/4 inch solid posts with 2-1/2 inch by 1/2 inch horizontal flats spaced as required, with top rail of two bronze, aluminum or steel channels and steel stiffener. Post at upper level of center railings shall be of malleable cast iron of height required, tapering from 1-3/4 inches at bottom to 1-1/4 inches at top, with finial. All posts shall be leaded-in 4 inches in cheeks and steps.

E. Wicket Guard and Fence

1. Furnish and install wicket guard fence 12 inches high constructed of 1/2 inch round bent steel rods welded together, to form a continuous wicket fence around the concrete curbing at seeded and planted areas. This guard fence shall be set in concrete footing specified under Division 03 Section "Cast-in-place Concrete".

F. Pipe Railings

1. Furnish and erect wrought iron or steel pipe railings and hand rails together with all fittings, flanges, collars, brackets, bolts, etc. of sizes required, all put together and secured in place in a thorough manner. All pipe railings shall be welded assembly, with continuous "V" joints, full thickness of pipe wall, welds filled solid and ground smooth. All radii, curves, sweeps, bends, etc., as indicated on details for pipe fitting assembly shall be maintained in the welded assembly. For pipe handrails in connection with stairs, see Division 05 Section "Pipe And Tube Railings".
2. Center pipe rails and free standing end pipe railings on outside concrete steps shall be made of 1-1/2 inch nominal diameter pipe and have pipe uprights with cast-iron collar and cap fittings secured in place with tap screws. The uprights shall be leaded-in pipe sleeves. Upright at upper level of center radii shall be of 2 inch nominal diameter pipe with approved cap.
3. Handrails at side of outside steps against walls shall be 1 inch nominal diameter pipes, with returns against wall at ends, and supported on galvanized cast-iron brackets and wall plates same as specified for egress stair.
4. Handrails at side of outside steps against iron fences shall be 1 inch nominal diameter, with returns at ends and supported on wrought iron brackets and plates. Handrails at area walls shall be 1-1/4 inch nominal diameter.
5. All outside pipe railings and handrails including fittings, etc., shall be galvanized after fabrication.
6. Furnish the combined pipe sleeve and base plate and turn over same for setting in concrete work.
7. Exterior barrier rails (at areaways, etc.) shall be of 1-1/2 inch nominal diameter pipe; interior barrier rails (at pits, changes in floor levels, etc.) shall be 1-1/4 inch nominal diameter.

G. Chimney Caps

1. Chimneys shall be provided with cast-iron caps.

H. Cast-Iron Sills

1. Furnish cast-iron sills for exterior doors of bulkheads, etc. The sills shall be set in a bed of cement and be substantially secured with bolts or expansion bolts.

I. Expansion Joints

1. Furnish and install all rolled steel members with required anchors at structural expansion joints through slabs. Items cast in concrete shall be furnished when required for setting. Provide bronze plates as required; top surfaces of plates shall be "BRONZOGRIT" or approved equal.

J. Chimney Cleanout Doors



1. Furnish to the mason proper cleanout doors of sizes indicated for chimneys, of 10 gauge steel plate and steel flats. The doors shall have angle-iron frames with strap anchors. Hang door with two 4 x 4 inch steel hinges and secure door with a latch.
- K. Ladders
1. Furnish and set ladders 18 inches wide, constructed with steel plate stringers, 3/4 inch diameter single rung treads let in and welded to stringers, angle and flat braces, and when required shall have pipe hand rails all riveted together. Secure ladders with angle clip and expansion bolts at top, bottom and elsewhere as required.
- L. Ladder Rungs
1. When ladder rungs are indicated built into mason work, furnish to the mason 5/8 inch galvanized wrought-iron ladder rungs.
  2. Ladder rungs in concrete shall be 15 inches wide and shall be built into concrete every 14 inches in height projecting into walls 4 inches on each side.
  3. Ladder rungs in brickwork of chimney shall be 18 inches wide, and shall be built into brickwork every 5 courses in height, project 8 inches beyond face of wall and continue 8 inches into wall with a 2 inch return. First rung shall start 10 feet above roof level at chimney.
- M. Retractable Ladders, Staircases and Counter-Balanced Stairs
1. Fabrication: Shop fabricate and assemble to maximum extent practicable for installation on-site with minimal labor.
  2. Accessories
    - a. Provide brackets, spacers, etc, necessary for a complete installation.
      - 1) Brackets: 6063-T6 aluminum alloy.
      - 2) Pivot Pins, Springs, Masonry Bolts, Fasteners, and Base Plates: Stainless steel.
    - b. Provide removable deployment handle at lower access point of retractable ladders.  
**OR**  
Provide removable deployment handle at lower access point of retractable ladders and locking hub and padlock.
    - c. Fasteners for securement to wood construction: Stainless steel lag bolts; 3/8-inch (9.5 mm) diameter, 4-inches (100 mm) minimum embedment.
    - d. Fasteners for securement to steel construction: Stainless steel bolts, nuts, and washers; 3/8-inch (9.5 mm) diameter.
  3. Footing: Install concrete footing in accordance with manufacturer's requirements, and in compliance with Division 03 Section "Cast-in-place Concrete".
  4. Install components in strict compliance with manufacturer's instructions.
  5. Adjust And Clean
    - a. Adjust operating parts for smooth deployment and storage.
    - b. Remove scraps and debris; leave project site in clean and orderly condition.
    - c. Instruct Owner's representative in proper operation.
- N. Vent Back Frames in Exhaust Opening of Toilet Rooms
1. Furnish and install 12 gauge bent steel frames in exhaust openings in partitions of toilet rooms. Frames shall be set plumb in partitions to receive the vent grilles. Baffle plates are not required.
- O. Grilles in Exhaust Openings
1. Furnish and set in frames at exhaust openings in toilet partitions, approved pressed steel bar type grilles with baked on primer, as manufactured by Tuttle and Bailey, Catalog No. T-80, or approved equal. Grilles shall be secured with tap screws to the frame. The bars of grilles shall be fixed and of rigid construction and shall be set at the angle required. Submit sample of grille for approval.
  2. Furnish and install individually adjustable shutters attached to grille frames, in certain toilets where required. Grilles shall be bar type, equal to Register and Grille Mfg. Co. No. 3311 or Tuttle and Bailey No. A-77.



3. In general, vent openings are provided in partitions of all toilet rooms back of water closets; however, certain smaller toilets, are mechanically vented by means of vent openings in ceiling or in partitions close to ceilings.

P. Access Doors

1. Access doors and frames that are to be furnished and installed as part of the work of this Contract shall be furnished and installed under Division 08 Section "Access Doors And Frames".
2. Access doors and frames that are to be furnished and installed in metal lath and plaster walls and ceilings as part of the work of this Contract shall be constructed of high grade sheet steel with 16 gauge frames and 14 gauge doors. Doors shall be equipped with concealed hinges and cylinder locks all keyed alike (furnish six (6) keys); doors in ceilings may have screwdriver operated type of lock. Doors shall have one piece plain trim set flush with finish surface. Stock doors manufactured by Columbia Metal Product Co., Karp Metal Products Co., or approved equal complying with the specifications, may be accepted. Submit sample for approval if not already approved.

Q. Dressing Compartment Seat Frames

1. Where seats are indicated in dressing compartments, furnish and set 1/4 x 1-1/2 inch flat galvanized bent steel brackets.

R. Stainless Steel

1. Stainless Steel and Cabinet Top Supports: Furnish and install adjustable, stainless steel tubing forming legs to support the tops of sinks and cabinets together with the stainless steel screens, collars, plates, etc., of sizes required. The screens shall be wrapped around and tap screwed to the legs of sink tubing.
2. Stainless Steel Jambs at Dressing Compartments: Furnish and install 14 gauge stainless steel tube jambs at doors to dressing compartments adjoining shower stalls. These jambs shall be anchored to the structural facing tile partition with 14 gauge stainless steel straps.
3. Package Slide: Furnish and install stainless steel half round strips and anchors (type 304 (18-8)) for package slide to Receiving Room. Strips shall be plug welded to anchors.
4. Angle and Channel Guards: Furnish and install angle and channel guards in the kitchen and auxiliary areas. Guards shall be 12 gauge stainless steel satin finish of length and dimensions required, secured in place with oval head stainless steel bolts in expansion shields.
5. Stainless Steel Shelf: Furnish and install stainless steel shelves complete with brackets, of gauges required, generally in helps' locker room, over sinks in locker rooms, in eraser cleaning closets, art room and medical office.  
Note: All stainless steel shall be chrome nickel cold rolled alloy designated by trade name Stainless Steel 18-8, No. 4 Finish; it shall contain a minimum of 18% chromium, 8% nickel, and not more than 0.12% carbon, non-magnetic (straight chrome iron not accepted).

S. Lumber Rack

1. Furnish a lumber rack for the woodworking room and general crafts shop, constructed with angles and provided with chains and hoods as required.

T. Hanging Rods

1. Furnish and erect hanging rods of diameters required of wrought-iron or steel pipe supported on approved hangers, brackets or flanges cabinets, closets and elsewhere throughout the building where required.

U. Auditorium Loudspeaker Grilles

1. Furnish and install complete, two (2) loudspeaker grilles in Auditorium. Grilles shall be equal to Blumcraft Deluxe-Line. Grille facets shall have a bronze anodized finish on faces and brushed finish on backs. Supporting bars #258 to have dull black anodized finish.
2. Frame of grilles shall be equal to Blumcraft's trim section WF-4, anodized black, and be secured to masonry with stainless steel screws (slack painted heads) in expansion shields.



3. Sub-frame shall be formed from 1/4" thick aluminum bar with corners mitered, continuously welded and ground smooth and firmly secured in place. Provide continuous piano hinge with 3/16" stop angle.
  4. The inside surface of grille shall be entirely covered with black grille cloth equal to "Acousticloth", as manufactured by Merlang or "Lumite", as manufactured by Chicopee. Grille cloth shall be fastened in place. Submit samples for approval.
  5. Include continuous angles and all other angles, plates, bars and reinforcing channels, all as required.
  6. Contractor is to verify all dimensions at job before fabricating any of the work.
  7. Loudspeaker enclosure and sound absorbing blanket will be furnished and installed as part of the work of Division 27 Section "Public Address And Mass Notification Systems".
- V. Bronze Saddles (Exterior)
1. All exterior door saddles shall be of bronze unless otherwise indicated. White bronze shall be provided for aluminum doors. Finish shall be "Bronzogrit" or an approved equal.
- W. Bronze Expansion Saddles (Interior)
1. Furnish and install bronze expansion saddles generally in the following areas: doors opening off auditorium platform or stage; gymnasium; dance room. None required in store room. Saddles shall consist of bronze flats, plates, and angle clips. Installation shall allow for 3/4 inch expansion. Exposed surfaces of plates and flats shall be "Bronzogrit" or approved equal.
- X. Bronze Pipe and Tubes
1. Furnish 1 inch square bronze tubes in toilet rooms and pipe spaces. Tubes shall be turned over to mason for installation. Tubes shall be of proper length (not less than full thickness of wall) and provided with bronze wire bars at one end.
- Y. Aluminum Hat and Coat Racks and Hook Strips
1. Furnish and install hat and coat racks and hook strips in locations required. Racks and hook strips shall be constructed of aluminum channels, flats and tubing of sizes required, toggle or expansion bolted to walls to suit conditions. Aluminum shall have alumilite finish.
  2. Submit shop drawings for approval.
- Z. Aluminum Angles for Showers
1. Furnish and install aluminum angle bracing as required. Angles shall have alumilite finish. Submit shop drawings for approval prior to fabrication.
- AA. Aluminum Railings
1. Center and side rails and wall handrails shall be of aluminum when required. Posts and horizontal members shall be solid. Posts shall be 1-1/2 inches square, extend through intermediate rails, secured to top rail with 3/8 inch stud bolts; posts at upper level shall be of height indicated, tapering from 1-3/4 inches at bottom to 1-1/4 inches at top, with finial. Posts shall be solidly set with molten sulphur or other approved non-electrolytic material into a combination 1/4 inch pipe sleeve and base plate welded to same, sleeve shall be welded to stair stringer or tread to suit condition, or set in concrete sub-stair.
  2. Exterior Aluminum Railings shall be constructed required. Aluminum posts shall be solid 1-1/2 inches square, extend through bottom rail, let into top rail and continuously welded. Center railing shall have tapered aluminum post of size and taper as required for "center rail". Rails shall be formed to shape indicated from, 3" x 1" solid aluminum flats with rounded edges.
  3. Roof railing shall be as required.
  4. Grab bars in toilets where indicated.
  5. All aluminum railings shall have finish equal to 204-C2 Aluminum Co. of America.
- BB. Miscellaneous Ornamental Metal Work
1. Include all other ornamental metal work. Submit shop drawings for approval.



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CC. Hardware

1. All hardware specified under Ornamental Metal Work shall match the approved samples in the office of the Owner. One sample of each item shall be submitted for approval of the Owner.
2. The key to all locks furnished under Ornamental Metal Work shall be provided with brass tags attached to the key with a strong metal ring or link and be similar to the tags specified under Hardware. The tags shall have stamped upon them the letters the Owner and the name or number of the room, closets, etc., for which the keys are intended.
3. All type C padlocks mentioned in this Section will be furnished as specified under Hardware. The Contractor for Ornamental Metal Work shall rivet padlock chains referred to in this Section in place.

DD. Painting

1. All Ornamental Metal Work and cast-iron work excepting cast-iron work to be set in concrete and galvanized items shall be thoroughly cleaned and painted one shop coat specified in Division 07.
2. After installation, all damaged surfaces of shop coat and all rough surfaces shall be scraped or sanded smooth and then touched up.

END OF SECTION 05 73 00 00a



## SECTION 05 73 00 00b - ORNAMENTAL RAILINGS

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. Section Includes:
  - a. Aluminum decorative railings with stainless-steel, wire-rope guard infill, **as directed**.
  - b. Copper-alloy decorative railings.
  - c. Stainless-steel decorative railings with stainless-steel, wire-rope guard infill, **as directed**.
  - d. Steel and iron decorative railings with stainless-steel, wire-rope guard infill, **as directed**.
  - e. Glass- and plastic-supported railings.
  - f. Post-supported railings with glass infill.
  - g. Illuminated decorative railings.

#### C. Definitions

1. Railings: Guards, handrails, and similar devices used for protection of occupants at open-sided floor areas, pedestrian guidance and support, visual separation, or wall protection.

#### D. Performance Requirements

1. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
  - a. Aluminum: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.
  - b. Copper Alloys: 60 percent of minimum yield strength.
  - c. Stainless Steel: 60 percent of minimum yield strength.
  - d. Steel: 72 percent of minimum yield strength.
  - e. Glass: 25 percent of mean modulus of rupture (50 percent probability of breakage), as listed in "Mechanical Properties" in AAMA's Aluminum Curtain Wall Series No. 12, "Structural Properties of Glass."
    - 1) Requirement above is based on the 2006 International Building Code (IBC) for safety factor of 4.
3. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
  - a. Loads below are based on the 2006 International Building Code (IBC).
    - 1) Handrails and Top Rails of Guards:
      - a) Uniform load of 50 lbf/ft. (0.73 kN/m) applied in any direction.
      - b) Concentrated load of 200 lbf (0.89 kN) applied in any direction.
      - c) Uniform and concentrated loads need not be assumed to act concurrently.
    - 2) Infill of Guards:
      - a) Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
      - b) Infill load and other loads need not be assumed to act concurrently.
    - 3) Glass-Supported Railings: Support each section of top rail by a minimum of three glass panels or by other means so top rail will remain in place if any one panel fails.



4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
  - a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
5. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

#### E. Submittals

1. Product Data: For the following:
  - a. Manufacturer's product lines of railings assembled from standard components.
  - b. Grout, anchoring cement, and paint products.
2. LEED Submittals:
  - a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - a. For illuminated railings, include wiring diagrams and roughing-in details.
4. Samples: For each type of exposed finish required.
  - a. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
  - b. Each type of glass required.
  - c. Fittings and brackets.
  - d. Welded connections.
  - e. Brazed connections.
  - f. Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, and infill. Show method of finishing members at intersections. Samples need not be full height.
5. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Qualification Data: For qualified professional engineer **OR** testing agency, **as directed**.
7. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.
8. Welding certificates.
9. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

#### F. Quality Assurance

1. Source Limitations: Obtain each type of railing from single source from single manufacturer.
2. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including structural analysis, preconstruction testing, field testing, and in-service performance.
  - a. Do not modify intended aesthetic effects, as judged solely by the Owner, except with the Owner's approval. If modifications are proposed, submit comprehensive explanatory data to the Owner for review.
3. Welding Qualifications: Qualify procedures and personnel according to the following:
  - a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
  - c. AWS D1.6, "Structural Welding Code - Stainless Steel."



4. Safety Glazing Labeling: Permanently mark glass with certification label of the SGCC **OR** the SGCC or another certification agency acceptable to authorities having jurisdiction **OR** manufacturer, **as directed**. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Preinstallation Conference: Conduct conference at Project site.

G. Project Conditions

1. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

H. Coordination And Scheduling

1. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
2. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
3. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not suit structural performance requirements.

## 1.2 PRODUCTS

A. Metals, General

1. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
2. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.
  - a. Provide cast-metal brackets with flange tapped for concealed anchorage to threaded hanger bolt.
  - b. Provide either formed- or cast-metal brackets with predrilled hole for exposed bolt anchorage.
  - c. Provide formed-steel brackets with predrilled hole for bolted anchorage and with snap-on cover that matches rail finish and conceals bracket base and bolt head.
  - d. Provide extruded-aluminum brackets with interlocking pieces that conceal anchorage. Locate set screws on bottom of bracket.

B. Aluminum

1. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
2. Extruded Bars and Shapes, Including Extruded Tubing: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.
3. Extruded Structural Pipe and Round Tubing: ASTM B 429/B 429M, Alloy 6063-T6.
  - a. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.
4. Drawn Seamless Tubing: ASTM B 210 (ASTM B 210M), Alloy 6063-T832.
5. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 5005-H32 **OR** Alloy 6061-T6, **as directed**.
6. Die and Hand Forgings: ASTM B 247 (ASTM B 247M), Alloy 6061-T6.
7. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.
8. Perforated Metal: Aluminum sheet, ASTM B 209 (ASTM B 209M), Alloy 6061-T6, 0.063 inch (1.60 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows.



9. Woven-Wire Mesh: Intermediate-crimp, diamond **OR** square, **as directed**, pattern, 2-inch (50-mm) woven-wire mesh, made from 0.162-inch (4.1-mm) nominal diameter wire complying with ASTM B 211 (ASTM B 211M), Alloy 6061-T94.

#### C. Copper Alloys

1. Copper and Copper Alloys, General: Provide alloys indicated and with temper to suit application and forming methods, but with strength and stiffness not less than Temper H01 (quarter hard) for plate, sheet, strip, and bars and Temper H55 (light drawn) for tube and pipe.
2. Extruded Shapes, Bronze: ASTM B 455, Alloy UNS No. C38500 (architectural bronze).
3. Extruded Shapes, Brass: ASTM B 249/B 249M, Alloy UNS No. C36000 (free-cutting brass).
4. Extruded Shapes, Nickel Silver: ASTM B 249/B 249M, Alloy UNS No. C79600.
5. Seamless Pipe, Bronze: ASTM B 43, Alloy UNS No. C23000 (red brass, 85 percent copper).
6. Seamless Tube, Bronze: ASTM B 135 (ASTM B 135M), Alloy UNS No. C23000 (red brass, 85 percent copper).
7. Seamless Tube, Brass: ASTM B 135 (ASTM B 135M), Alloy UNS No. C26000 (cartridge brass, 70 percent copper).
8. Seamless Tube, Copper: ASTM B 75 (ASTM B 75M), Alloy UNS No. C12200 (phosphorous deoxidized, high residual phosphorous copper).
9. Castings, Bronze: Composition bronze castings complying with ASTM B 62, Alloy UNS No. C83600 (85-5-5-5 or No. 1 composition commercial red brass) or sand castings complying with ASTM B 584, Alloy UNS No. C86500 (No. 1 manganese bronze).
10. Castings, Brass: Sand castings complying with ASTM B 584, Alloy UNS No. C85200 (high-copper yellow brass).
11. Castings, Copper: ASTM B 824, with a minimum of 99.9 percent copper.
12. Castings, Nickel Silver: ASTM B 584, Alloy UNS No. C97300 (12 percent leaded nickel silver).
13. Plate, Sheet, Strip, and Bars; Bronze: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper).
14. Plate, Sheet, Strip, and Bars; Brass: ASTM B 36/B 36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper).
15. Plate, Sheet, Strip, and Bars; Copper: ASTM B 152/B 152M, Alloy UNS No. C11000 (electrolytic tough pitch copper) or Alloy UNS No. C12200 (phosphorous deoxidized, high-residual phosphorous copper).

#### D. Stainless Steel

1. Tubing: ASTM A 554, Grade MT 304 **OR** Grade MT 316 **OR** Grade MT 316L, **as directed**.
2. Pipe: ASTM A 312/A 312M, Grade TP 304 **OR** Grade TP 316 **OR** Grade TP 316L, **as directed**.
3. Castings: ASTM A 743/A 743M, Grade CF 8 or CF 20 **OR** Grade CF 8M or CF 3M, **as directed**.
4. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 304 **OR** Type 316 **OR** Type 316L, **as directed**.
5. Bars and Shapes: ASTM A 276, Type 304 **OR** Type 316 **OR** Type 316L, **as directed**.
6. Wire Rope and Fittings:
  - a. Wire Rope: 1-by-19 **OR** 7-by-7 **OR** 7-by-19, **as directed**, wire rope made from wire complying with ASTM A 492, Type 316.
  - b. Wire-Rope Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.
7. Expanded Metal: ASTM F 1267, Type I (expanded) **OR** Type II (expanded and flattened), **as directed**, Class 3 (corrosion-resisting steel), made from stainless-steel sheet complying with ASTM A 666, Type 304 **OR** Type 316, **as directed**.
  - a. Style Designation: 3/4 number 13 **OR** 1-1/2 number 10, **as directed**.
8. Perforated Metal: Stainless-steel sheet, ASTM A 240/A 240M or ASTM A 666, Type 304 **OR** Type 316L, **as directed**, 0.062 inch (1.59 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows.



9. Woven-Wire Mesh: Intermediate-crimp, diamond **OR** square, **as directed**, pattern, 2-inch (50-mm) woven-wire mesh, made from 0.135-inch (3.5-mm) nominal diameter wire complying with ASTM A 580/A 580M, Type 304 **OR** Type 316, **as directed**.
- E. Steel And Iron
1. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
  2. Tubing: ASTM A 500 (cold formed) or ASTM A 513.
  3. Bars: Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.
  4. Plates, Shapes, and Bars: ASTM A 36/A 36M.
  5. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
  6. Expanded Metal: ASTM F 1267, Type I (expanded) **OR** Type II (expanded and flattened), **as directed**, Class 1 (uncoated).
    - a. Style Designation: 3/4 number 13 **OR** 1-1/2 number 10, **as directed**.
  7. Perforated Metal: Cold-rolled steel sheet, ASTM A 1008/A 1008M, or hot-rolled steel sheet, ASTM A 1011/A 1011M, commercial steel Type B, 0.060 inch (1.52 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows.

**OR**

Perforated Metal: Galvanized-steel sheet, ASTM A 653/A 653M, G90 (Z275) coating, commercial steel Type B, 0.064 inch (1.63 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows **OR** with 1/8-by-1-inch (3.2-by-25.4-mm) round end slotted holes in staggered rows, **as directed**.
  8. Woven-Wire Mesh: Intermediate-crimp, diamond **OR** square, **as directed**, pattern, 2-inch (50-mm) woven-wire mesh, made from 0.135-inch (3.5-mm) nominal diameter wire complying with ASTM A 510 (ASTM A 510M).
- F. Glass And Glazing Materials
1. Tempered Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated), Type 1 (transparent flat glass), Quality-Q3. Provide products that have been tested for surface and edge compression according to ASTM C 1048 and for impact strength according to 16 CFR 1201 for Category II materials.
    - a. Glass Color: Clear **OR** Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
    - b. Thickness for Structural Glass Balusters: As required by structural loads, but not less than 12.0 **OR** 19.0, **as directed**, mm.
    - c. Thickness for Glass Infill Panels: As required by structural loads, but not less than 6.0 **OR** 10.0, **as directed**, mm.

**OR**

Thickness: As indicated on Drawings.
  2. Laminated Glass: ASTM C 1172, Condition A (uncoated), Type I (transparent flat glass), Quality-Q3 with two plies of glass and polyvinyl butyral interlayer not less than 0.060 inch (1.52 mm) thick.
    - a. Kind: LA (laminated annealed) **OR** LHS (laminated heat strengthened) **OR** LT (laminated tempered) **OR** As indicated, **as directed**.
    - b. Glass Color: Clear **OR** Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
    - c. Interlayer Color: Clear **OR** Blue-green **OR** Bronze light **OR** Gray **OR** As selected from manufacturer's full range, **as directed**.
    - d. Glass Plies for Structural Glass Balusters: Thickness required by structural loads, but not less than 6.0 **OR** 8.0, **as directed**, mm thick, each.
    - e. Glass Plies for Glass Infill Panels: Thickness required by structural loads, but not less than 3.0 **OR** 4.0 **OR** 5.0, **as directed**, mm, each.
  3. Ceramic-Coated Glass: Heat-treated float glass, Condition C; with ceramic enamel applied by silk-screened process; complying with Specification No. 95-1-31 in GANA's "Engineering Standards Manual" and with other requirements specified.



- a. Glass Color: Clear **OR** Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray **OR** As selected from manufacturer's full range, **as directed**.
4. Plastic Structural Glazing: Uncoated, transparent, monolithic acrylic sheet complying with ASTM D 4802, Category A-1 or A-2 (cell cast or continuous cast), Finish 1 (smooth or polished), and as follows:
  - a. Color: Colorless (clear) **OR** Blue **OR** Blue-green **OR** Bronze **OR** Gray **OR** Green **OR** Match glass, **as directed**.
  - b. Thickness: 12.0 mm **OR** Match glass thickness, **as directed**.
5. Glazing Cement and Accessories for Structural Glazing: Glazing cement, setting blocks, shims, and related accessories as recommended or supplied by railing manufacturer for installing structural glazing in metal subrails.
  - a. Glazing Cement: Nonshrinking organic cement designed for curing by passing an electric current through metal subrail holding glass panel, as standard with manufacturer.
6. Glazing Gaskets for Glass Infill Panels: Glazing gaskets and related accessories recommended or supplied by railing manufacturer for installing glass infill panels in post-supported railings.

#### G. Fasteners

1. Fastener Materials: Unless otherwise indicated, provide the following:
  - a. Aluminum Components: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
  - b. Copper-Alloy (Bronze) Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners where concealed; muntz metal (Alloy 280) fasteners where exposed.
  - c. Copper-Alloy (Brass) Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners where concealed; brass (Alloy 260 or Alloy 360) fasteners where exposed.
  - d. Stainless-Steel Components: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
  - e. Uncoated Steel Components: Plated-steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed; Type 304 stainless-steel fasteners where exposed.
  - f. Galvanized-Steel Components: Plated-steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
  - g. Dissimilar Metals: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
2. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads, **as directed**.
3. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless otherwise indicated **OR** exposed fasteners are unavoidable **OR** exposed fasteners are the standard fastening method for railings indicated, **as directed**.
  - a. Provide Phillips **OR** tamper-resistant **OR** square or hex socket, **as directed**, flat-head machine screws for exposed fasteners unless otherwise indicated.
4. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
5. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
  - a. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
  - b. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**, stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

#### H. Miscellaneous Materials

1. Wood Rails: Clear, straight-grained hardwood rails secured to recessed **OR** exposed, **as directed**, metal subrail.
  - a. Species: Ash **OR** Cherry **OR** Red oak **OR** Walnut **OR** White oak, **as directed**.



- b. Finish: Manufacturer's standard **OR** Transparent polyurethane **OR** Penetrating oil **OR** Acrylic impregnated, **as directed**.
- c. Staining: None **OR** Match the Owner's sample **OR** As selected from manufacturer's full range, **as directed**.
- d. Profile: Square, 1-3/4 by 1-3/4 inches (45 by 45 mm) with edges eased to 1/4-inch (6-mm) radius **OR** Rectangular, 1-3/4 by 5 inches (45 by 127 mm) with edges eased to 1/4-inch (6-mm) radius **OR** Round, 2-inch (50-mm) diameter **OR** As indicated, **as directed**.

**OR**

Wood Rails: Hardwood rails complying with Division 06 Section "Interior Architectural Woodwork"

2. Electrical Components: Provide internal, fluorescent light fixtures and electrical components, required as part of illuminated railings, that comply with NFPA 70 and that are listed and labeled by UL.
3. Plastic Handrail Caps: Thermoplastic rail covering, color as indicated or, if not indicated, as selected by the Owner from manufacturer's standard colors.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
  - a. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
5. Brazing Rods: For copper-alloy railings, provide type and alloy as recommended by producer of metal to be brazed and as required for color match, strength, and compatibility in fabricated items.
6. Lacquer for Copper Alloys: Clear acrylic lacquer specially developed for coating copper-alloy products.
7. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
8. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
9. Shop Primers: Provide primers that comply with Division 07 **OR** Division 09 Section(s) "High-performance Coatings" **OR** Division 07 **AND** Division 09 Section(s) "High-performance Coatings", **as directed**.
10. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
  - a. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
11. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
12. Shop Primer for Galvanized Steel: Cementitious galvanized metal primer complying with MPI#26 **OR** Vinyl wash primer complying with MPI#80 **OR** Water-based galvanized metal primer complying with MPI#134, **as directed**.
13. Intermediate Coats and Topcoats: Provide products that comply with Division 07 **OR** Division 09 Section(s) "High-performance Coatings" **OR** Division 07 **AND** Division 09 Section(s) "High-performance Coatings", **as directed**.
14. Epoxy Intermediate Coat: Complying with MPI#77 and compatible with primer and topcoat.
15. Polyurethane Topcoat: Complying with MPI#72 and compatible with undercoat.
16. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
17. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
18. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
  - a. Water-Resistant Product: At exterior locations and where indicated provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

**I. Fabrication**

1. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.



2. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
3. Make up wire-rope assemblies in the shop to field-measured dimensions with fittings machine swaged. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.
4. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
5. Form work true to line and level with accurate angles and surfaces.
6. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
7. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
8. Connections: Fabricate railings with welded or nonwelded connections unless otherwise indicated.
9. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
  - a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - b. Obtain fusion without undercut or overlap.
  - c. Remove flux immediately.
  - d. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.
10. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.
11. Brazed Connections: Connect copper-alloy railings by brazing. Cope components at connections to provide close fit, or use fittings designed for this purpose. Braze corners and seams continuously.
  - a. Use materials and methods that match color of base metal, minimize distortion, and develop maximum strength and corrosion resistance.
  - b. Remove flux immediately.
  - c. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and brazed surface matches contours of adjoining surfaces.
12. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
  - a. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
13. Form changes in direction as follows:
  - a. As detailed.  
**OR**  
By bending or by inserting prefabricated elbow fittings.  
**OR**  
By flush bends or by inserting prefabricated flush-elbow fittings.  
**OR**  
By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.  
**OR**  
By bending to smallest radius that will not result in distortion of railing member.
14. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
15. Close exposed ends of hollow railing members with prefabricated end fittings.



16. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns, unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.
  17. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
    - a. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
  18. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
  19. For railing posts set in concrete, provide steel **OR** stainless-steel, **as directed**, sleeves not less than 6 inches (150 mm) long with inside dimensions not less than 1/2 inch (13 mm) greater than outside dimensions of post, with metal plate forming bottom closure.
  20. For removable railing posts, fabricate slip-fit sockets from steel **OR** stainless-steel, **as directed**, tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.
    - a. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.
  21. Expanded-Metal Infill Panels: Fabricate infill panels from stainless-steel **OR** steel, **as directed**, expanded metal unless otherwise indicated.
    - a. Edge panels with U-shaped channels made from same metal as infill; not less than 0.043 inch (1.1 mm) thick.
    - b. Orient expanded metal with long dimension of diamonds parallel to top rail **OR** perpendicular to top rail **OR** horizontal **OR** vertical, **as directed**.
  22. Perforated-Metal Infill Panels: Fabricate infill panels from perforated metal made from steel **OR** galvanized steel **OR** aluminum **OR** stainless steel **OR** same metal as railings in which they are installed, **as directed**.
    - a. Edge panels with U-shaped channels made from metal sheet, of same metal as perforated metal and not less than 0.043 inch (1.1 mm) thick.
    - b. Orient perforated metal with pattern parallel to top rail **OR** perpendicular to top rail **OR** horizontal **OR** vertical **OR** as indicated on Drawings, **as directed**.
  23. Woven-Wire Mesh Infill Panels: Fabricate infill panels from woven-wire mesh crimped into 1-by-1/2-by-1/8-inch (25-by-13-by-3-mm) metal channel frames.
    - a. Make wire mesh and frames from aluminum **OR** stainless steel **OR** steel, **as directed**, unless otherwise indicated.
    - b. Orient wire mesh with diamonds vertical **OR** wires perpendicular and parallel to top rail **OR** wires horizontal and vertical, **as directed**.
  24. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.
- J. Glazing Panel Fabrication
1. General: Fabricate to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.
    - a. Clean-cut or flat-grind edges at butt-glazed sealant joints to produce square edges with slight chamfers at junctions of edges and faces
    - b. Grind smooth exposed edges, including those at open joints, to produce square edges with slight chamfers at junctions of edges and faces.
  2. Structural Glass Balusters: Factory-bond glass to aluminum base and top-rail channels in railing manufacturer's plant using glazing cement to comply with manufacturer's written specifications, unless field glazing is standard with manufacturer.
  3. Structural Balusters: Provide tempered **OR** laminated, heat-strengthened **OR** laminated, tempered, **as directed**, glass panels for both straight and curved sections, **as directed**.  
**OR**



Structural Balusters: Provide thermoformed, curved, plastic glazing panels for curved sections and tempered **OR** laminated, heat-strengthened **OR** laminated, tempered, **as directed**, glass panels for straight sections.

**OR**

Infill Panels: Provide tempered **OR** laminated, annealed **OR** laminated, heat-strengthened **OR** laminated, tempered, **as directed**, glass panels for both straight and curved sections, **as directed**.

#### K. Illuminated Railings

1. General: Comply with requirements in this Section for aluminum railings with welded connections.
2. Illuminated Units: Provide internal illumination using concealed, internally wired, fluorescent-strip fixture system to illuminate walking surfaces adjacent to railings without light leaks. Make provisions for servicing and for concealed connection to electric service. Coordinate electrical characteristics with those of the power supply provided.
  - a. Fluorescent Tubes: Provide number of tubes indicated or required by railing length.
  - b. Diffusers: UV-stabilized acrylic diffusers matching profile of railings.
  - c. Ballasts: Energy-saving, high power factor, Class P, electromagnetic type; designed for use with high-output lamps, and with automatic-reset thermal protection. Ballasts comply with ANSI C82.1, bear Certified Ballast Manufacturer Certification labels, and are rated for 0 deg F (minus 17 deg C) **OR** minus 20 deg F (minus 29 deg C), **as directed**, starting temperature.

#### L. General Finish Requirements

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.
3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
4. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

#### M. Aluminum Finishes

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Mechanical Finish: AA-M3x (Mechanical Finish: as specified); sand top rails, handrails, and intermediate rails in one direction only, parallel to length of railing, with 120- and 320-grit abrasive. After installation, polish railings with No. 0 steel wool immersed in paste wax, then rub to a luster with a soft dry cloth.
3. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
4. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
  - a. Color: Champagne **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.
5. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
  - a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.



6. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
  - a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
7. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

**OR**

- High-Performance Organic Finish: Three **OR** Four, **as directed**,-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
- b. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

**N. Copper-Alloy Finishes**

1. Finish designations for copper alloys comply with the system for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
2. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).
3. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).
4. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).
5. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).
6. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear organic, air drying, as specified below).
  - a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
7. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear organic, air drying, as specified below).
  - a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
8. Medium-Satin Finish, Lacquered: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below).
  - a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
9. Fine-Matte Finish, Lacquered: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear organic, air drying, as specified below).
  - a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
10. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide), with color matching the Owner's sample.
11. Patina Conversion Coating: M36-C12-C52 (Mechanical Finish: directionally textured, uniform; Chemical Finish: nonetched cleaned, degreased; Chemical Finish: conversion coating, ammonium sulfate), with color matching the Owner's sample.

**O. Stainless-Steel Finishes**



1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
  - a. Run grain of directional finishes with long dimension of each piece.
3. Directional Satin Finish: No. 4.
4. Dull Satin Finish: No. 6.
5. Satin, Reflective, Directional Polish: No. 7.
6. Mirrorlike Reflective, Nondirectional Polish: No. 8.
7. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
8. Sputter-Coated Finish: Titanium nitride coating deposited by magnetic sputter-coating process over indicated mechanical finish.

P. Steel And Iron Finishes

1. Galvanized Railings:
  - a. Hot-dip galvanize steel **OR** exterior steel, **as directed**, and iron railings, including hardware, after fabrication.
  - b. Hot-dip galvanize indicated steel and iron railings, including hardware, after fabrication.
  - c. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
  - d. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.
  - e. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
  - f. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
2. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
3. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
4. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or masonry.
5. Preparing Nongalvanized Items for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" **OR** SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning" **OR** requirements indicated below, **as directed**:
  - a. Exterior Railings: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - b. Railings Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - c. Railings Indicated to Receive Primers Specified in Division 9 Section "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - d. Other Railings: SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
6. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
  - a. Shop prime uncoated railings with universal shop primer **OR** primers specified in Division 07, **as directed**, unless zinc-rich primer is **OR** primers specified in Division 09 Section "High-performance Coatings" are, **as directed**, indicated.
  - b. Do not apply primer to galvanized surfaces.
7. Shop-Painted Finish: Comply with Division 09 Section(s) "Exterior Painting" **OR** "High-performance Coatings", **as directed**.
  - a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
8. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.



- a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
9. Powder-Coat Finish: Prepare, treat, and coat nongalvanized ferrous metal to comply with resin manufacturer's written instructions and as follows:
  - a. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - b. Treat prepared metal with iron-phosphate pretreatment, rinse, and seal surfaces.
  - c. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm).
  - d. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
10. Powder-Coat Finish: Prepare, treat, and coat galvanized metal to comply with resin manufacturer's written instructions and as follows:
  - a. Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
  - b. Treat prepared metal with zinc-phosphate pretreatment, rinse, and seal surfaces.
  - c. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm).
  - d. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

### 1.3 EXECUTION

#### A. Examination

1. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

#### B. Installation, General

1. Fit exposed connections together to form tight, hairline joints.
2. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
  - a. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
  - b. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
  - c. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (5 mm in 3 m).
3. Corrosion Protection: Coat concealed surfaces of aluminum and copper alloys that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
4. Adjust railings before anchoring to ensure matching alignment at abutting joints.
5. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

#### C. Railing Connections

1. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
2. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.



3. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

#### D. Anchoring Posts

1. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
2. Form or core-drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
3. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material **OR** attached to post with set screws, **as directed**.  
**OR**  
Leave anchorage joint exposed with 1/8-inch (3-mm) buildup, sloped away from post **OR** anchoring material flush with adjacent surface, **as directed**.
4. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
  - a. For aluminum railings, attach posts as indicated using fittings designed and engineered for this purpose.
  - b. For copper-alloy railings, attach posts as indicated using fittings designed and engineered for this purpose.
  - c. For stainless-steel railings, weld flanges to posts and bolt to metal-supporting surfaces.
  - d. For steel railings, weld flanges to posts and bolt to metal-supporting surfaces.
5. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

#### E. Attaching Railings

1. Anchor railing ends to concrete and masonry with sleeves concealed within **OR** flanges connected to **OR** brackets on underside of rails connected to, **as directed**, railing ends and anchored to wall construction with anchors and bolts.
2. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends or connected to railing ends using nonwelded connections.
3. Attach handrails to walls with wall brackets except where end flanges are used. Provide brackets with 1-1/2-inch (38-mm) clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
  - a. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt **OR** predrilled hole for exposed bolt anchorage, **as directed**.
  - b. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
4. Secure wall brackets and railing end flanges to building construction as follows:
  - a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
  - b. For hollow masonry anchorage, use toggle bolts.
  - c. For wood stud partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with carpentry work to locate backing members.
  - d. For steel-framed partitions, use hanger or lag bolts set into fire-retardant-treated, **as directed**, wood backing between studs. Coordinate with stud installation to locate backing members.  
**OR**  
For steel-framed partitions, fasten brackets directly to steel framing or concealed steel reinforcements using self-tapping screws of size and type required to support structural loads.

**OR**

For steel-framed partitions, fasten brackets with toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

**F. Installing Glass Panels**

1. Glass-Supported Railings: Install assembly to comply with railing manufacturer's written instructions.
  - a. Attach base channel to building structure, then insert and connect factory-fabricated and -assembled glass panels if glass was bonded to base and top rail channels in factory.
  - b. Attach base channel to building structure, then insert glass into base channel and bond with glazing cement unless glass was bonded to base and top rail channels in factory.
    - 1) Support glass panels in base channel at quarter points with channel-shaped setting blocks that also act as shims to maintain uniform space for glazing cement. Fill remaining space in base channel with glazing cement for uniform support of glass.
  - c. Adjust spacing of glass panels so gaps between panels are equal before securing in position.
  - d. Erect glass railings under direct supervision of manufacturer's authorized technical personnel.
2. Post-Supported Glass Railings: Install assembly to comply with railing manufacturer's written instructions and with requirements in other Part 1.3 articles. Erect posts and other metal railing components, then set factory-cut glass panels. Do not cut, drill, or alter glass panels in field. Protect edges from damage.

**G. Installing Plastic Handrail Caps**

1. Apply plastic handrail caps to top rails and handrails, where indicated, complying with manufacturer's written instructions for cutting, mounting, forming, welding, cleaning, applying end caps, and finishing.
2. Minimize number of joints in plastic caps by installing in lengths as long as possible. Allow for shortening of plastic cap caused by welding and splicing process; butt ends together to produce hairline joint.
  - a. Continuously weld, splice, miter, and end-cap joints using cap manufacturer's electric welding iron designed for this purpose. Remove welding flash while material is still soft.
  - b. Weld only prongs on underside of plastic cap at splice, miter, and end-cap joints. After cutting plastic cap, dress ends with file to produce a hairline fit between abutting sections. After mounting cap, polish top surface with cap manufacturer's solvent designed for this purpose until joint becomes almost invisible.

**H. Field Quality Control**

1. Testing Agency: Perform field tests and inspections and prepare test reports.
2. Extent and Testing Methodology: Randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Railings will be tested according to ASTM E 894 and ASTM E 935 for compliance with performance requirements.
3. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory to the Owner and will comply with specified requirements.
4. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

**I. Cleaning**

1. Clean aluminum and stainless steel by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.
2. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.



3. Clean and polish glass and plastic glazing as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Final Completion.
4. Clean wood rails and plastic handrail caps by wiping with a damp cloth and then wiping dry.
5. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
  - a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

**OR**

Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
6. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

J. Protection

1. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Final Completion.
2. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05 73 00 00b



## SECTION 05 75 00 00 - ORNAMENTAL FORMED METAL

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. Section Includes:
  - a. Beam wraps.
  - b. Closures and trim.
  - c. Column covers.
  - d. Decorative-metal-clad, hollow-metal doors and frames.
  - e. Elevator cab and entrance finishes.
  - f. Escalator enclosures.
  - g. Filler panels at demountable partitions and/or between dissimilar construction.
  - h. Heating-cooling unit enclosures.
  - i. Lighting coves.
  - j. Metal base.
  - k. Mullion cladding.
  - l. Pipe system covers.
  - m. Pockets for window treatment.
  - n. Window stools.
  - o. Exterior fins.
  - p. Exterior formed-metal-shaped panels.
  - q. Exterior sunshades.
  - r. Exterior trellises.
  - s. Exterior window covers.
  - t. Metal shapes as part of roof construction.

#### C. Performance Requirements

1. Delegated Design: Design exterior decorative formed metal items, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance: Decorative formed metal items, including anchors and connections, shall withstand the effects of gravity loads and the following loads and stresses without exceeding the allowable design working stress of materials involved and without exhibiting permanent deformation in any components:
  - a. Wind Loads on Exterior Items: As indicated on Drawings **OR** 20 lbf/sq. ft. (957 Pa) **OR** 30 lbf/sq. ft. (1436 Pa) **OR** As required to meet local Project requirements.
  - b. Live Loads on Heating-Cooling Unit Enclosures: 100 lbf/sq. ft. (4.8 kN/sq. m) or a concentrated load of 300 lbf (1.3 kN) on an area of 4 sq. in. (26 sq. cm), whichever produces the greater stress.
3. Seismic Performance: Exterior decorative formed metal items, including anchors and connections, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - a. Component Importance Factor is 1.0.
4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.



- a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
5. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

#### D. Submittals

1. Product Data: For each type of product indicated. Include finishing materials.
2. LEED Submittals:
  - a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
  - b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: Show fabrication and installation details for decorative formed metal.
  - a. Include plans, elevations, component details, and attachments to other work.
  - b. Indicate materials and profiles of each decorative formed metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.
4. Samples: For each type of exposed finish required, prepared on 6-inch- (150-mm-) square Samples of metal of same thickness and material indicated for the Work.
5. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Coordination Drawings: For decorative formed metal elements that house items specified in other Sections. Show dimensions of housed items, including locations of housing penetrations and attachments, and necessary clearances.
7. Qualification Data: For qualified Installer, fabricator, organic-coating applicator, anodic finisher, powder-coating applicator and professional engineer.
8. Mill Certificates: Signed by stainless-steel manufacturers certifying that products furnished comply with requirements.
9. Welding certificates.
10. Maintenance Data: For mirrorlike stainless-steel finish and statuary conversion coating copper-alloy finish to include in maintenance manuals.

#### E. Quality Assurance

1. Fabricator Qualifications: A firm experienced in producing decorative formed metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
2. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
3. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
4. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
5. Installer Qualifications: Fabricator of products.
6. Welding Qualifications: Qualify procedures and personnel according to the following:
  - a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
  - c. AWS D1.3, "Structural Welding Code - Sheet Steel."
  - d. AWS D1.6, "Structural Welding Code - Stainless Steel."



7. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling

1. Deliver decorative formed metal products wrapped in protective coverings and strapped together in suitable packs or in heavy-duty cartons. Remove protective coverings before they stain or bond to finished surfaces.
2. Store products on elevated platforms in a dry location.

G. Project Conditions

1. Field Measurements: Verify actual locations of walls, columns, beams, and other construction contiguous with decorative formed metal by field measurements before fabrication and indicate measurements on Shop Drawings.

H. Coordination

1. Coordinate installation of anchorages for decorative formed metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
2. Coordinate installation of decorative formed metal with adjacent construction to ensure that wall assemblies, flashings, trim, and joint sealants, are protected against damage from the effects of weather, age, corrosion, and other causes.

## 1.2 PRODUCTS

A. Sheet Metal

1. General: Provide sheet metal without pitting, seam marks, roller marks, stains, discolorations, or other imperfections where exposed to view on finished units.
2. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
3. Aluminum Sheet: Flat sheet complying with ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of Alloy 5005-H32.
4. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating, either commercial steel or forming steel.
5. Steel Sheet: Uncoated, cold-rolled, ASTM A 1008/A 1008M, commercial steel, exposed or electrolytic zinc-coated, ASTM A 879/A 879M, with steel sheet substrate complying with ASTM A 1008/A 1008M, commercial steel, exposed.
6. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304 **OR** Type 316, **as directed**, stretcher-leveled standard of flatness.
7. Bronze Sheet: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper) or Alloy UNS No. C23000 (red brass, 85 percent copper).
8. Brass Sheet: ASTM B 36/B 36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper).
9. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper.
10. Titanium Sheet: ASTM B 265, Grade 1.

B. Miscellaneous Materials

1. Gaskets: As required to seal joints in decorative formed metal and remain airtight **OR** weathertight, **as directed**; as recommended in writing by decorative formed metal manufacturer.
  - a. ASTM D 1056, Type 1, Class A, grade as recommended by gasket manufacturer to obtain seal for application indicated.
  - b. Closed-cell polyurethane foam, adhesive on two sides, release paper protected.
2. Sealants, Exterior: ASTM C 920; elastomeric silicone **OR** polyurethane **OR** polysulfide, **as directed**, sealant; of type, grade, class, and use classifications required to seal joints in



- decorative formed metal and remain weathertight; and as recommended in writing by decorative formed metal manufacturer.
3. Sealants, Interior: Nonsag, paintable, nonstaining, latex sealant complying with ASTM C 834; of type and grade required to seal joints in decorative formed metal; and as recommended in writing by decorative formed metal manufacturer.
    - a. Use sealant that has a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  4. Filler Metal and Electrodes: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded or brazed and as necessary for strength, corrosion resistance, and compatibility in fabricated items.
    - a. Use filler metals that will match the color of metal being joined and will not cause discoloration.
  5. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are incompatible with materials joined.
    - a. Provide concealed fasteners for interconnecting decorative formed metal items and for attaching them to other work unless otherwise indicated **OR** exposed fasteners are unavoidable or are the standard fastening method, **as directed**.
    - b. Provide Phillips **OR** tamper-resistant **OR** square or hex socket, **as directed**, flat-head machine screws for exposed fasteners unless otherwise indicated.
  6. Structural Anchors: For applications indicated to comply with certain design loads, provide chemical or torque-controlled expansion anchors with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
  7. Nonstructural Anchors: For applications not indicated to comply with design loads, provide powder-actuated fasteners **OR** metal expansion sleeve anchors **OR** metal-impact expansion anchors, **as directed**, of type, size, and material necessary for type of load and installation indicated, as recommended by manufacturer, unless otherwise indicated.
  8. Anchor Materials:
    - a. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
    - b. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**, stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).
  9. Sound-Deadening Materials:
    - a. Insulation: Unfaced, mineral-fiber blanket insulation complying with ASTM C 665, Type I, and passing ASTM E 136 test.
    - b. Mastic: Cold-applied asphalt emulsion complying with ASTM D 1187.
  10. Backing Materials: Provided or recommended by decorative formed metal manufacturer.
  11. Laminating Adhesive: Adhesive recommended by metal fabricator that will fully bond metal to metal and that will prevent telegraphing and oil canning and is compatible with substrate and noncombustible after curing.
    - a. Contact Adhesive: VOC content of not more than 80 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    - b. Metal-to-Metal Adhesive: VOC content of not more than 30 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    - c. Multipurpose Construction Adhesive: VOC content of not more than 70 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    - d. Special-Purpose Contact Adhesive: (Contact adhesive used to bond melamine-covered board, metal, unsupported vinyl, ultrahigh molecular weight polyethylene, and rubber or wood veneer, 1/16 inch thick or less, to any surface): 250 g/L.
  12. Isolation Coating: Manufacturer's standard alkali-resistant coating **OR** bituminous paint **OR** epoxy coating, **as directed**.



C. Paints And Coatings

1. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
2. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
3. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.
4. Shop Primers: Comply with Division 07 OR Division 09 Section(s) "High-performance Coatings", **as directed**.
5. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
  - a. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
6. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
7. Shop Primer for Galvanized Steel: Cementitious galvanized metal primer complying with MPI#26 **OR** Vinyl wash primer complying with MPI#80 **OR** Water-based galvanized metal primer complying with MPI#134, **as directed**.
8. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

D. Fabrication, General

1. Shop Assembly: Preassemble decorative formed metal items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
2. Coordinate dimensions and attachment methods of decorative formed metal items with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.
3. Form metal to profiles indicated, in maximum lengths to minimize joints. Produce flat, flush surfaces without cracking or grain separation at bends. Fold back exposed edges of unsupported sheet metal to form a 1/2-inch- (12-mm-) wide hem on the concealed side, or ease edges to a radius of approximately 1/32 inch (1 mm) and support with concealed stiffeners.
4. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use.
  - a. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.
5. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce decorative formed metal items as needed to attach and support other construction.
6. Provide support framing, mounting and attachment clips, splice sleeves, fasteners, and accessories needed to install decorative formed metal items.
7. Where welding or brazing is indicated, weld or braze joints and seams continuously. Grind, fill, and dress to produce smooth, flush, exposed surfaces in which joints are not visible after finishing is completed.
  - a. Use welding and brazing procedures that will blend with and not cause discoloration of metal being joined.

E. Beam Wraps

1. Form beam wraps from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction.
  - a. Aluminum Sheet: 0.063 inch (1.60 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
    - 1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
  - b. Steel Sheet: 0.060 inch (1.52 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
    - 1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.



- c. Stainless-Steel Sheet: 0.050 inch (1.27 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
  - 1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.
- 2. Fabricate with calk stop angle to retain backer rod and sealant.

#### F. Closures And Trim

- 1. Form closures and trim from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction, with weathertight joints at exterior installations.
  - a. Aluminum Sheet: 0.063 inch (1.60 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
    - 1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
  - b. Galvanized-Steel Sheet: 0.052 inch (1.32 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
    - 1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
  - c. Steel Sheet: 0.048 inch (1.21 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
    - 1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
  - d. Closures and trim may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view and not exposed to weather.
- 2. Conceal fasteners where possible; otherwise, locate where they are as inconspicuous as possible. Size fasteners to support closures and trim, with fasteners spaced to prevent buckling or waviness in finished surfaces.
- 3. Drill and tap holes needed for securing closures and trim to other surfaces.
- 4. Incorporate gaskets where indicated or needed for concealed, continuous seal at abutting surfaces.
- 5. Miter or cope trim members at corners and reinforce with bent metal splice plates to form tight joints.

#### G. Column Covers

- 1. Spackled-Seam Type: Form column covers from 0.125-inch (3.2-mm) aluminum, rolled to radii indicated. Taper edges of adjoining pieces of column covers, for taping and spackling, to 0.094-inch (2.4-mm) thickness in approximately 1 inch (25 mm) of width. Punch tapered edges for gypsum board screws at 1/2 inch (12 mm) o.c., and mill grooves in tapered edge to improve bond with joint compound.
  - a. Support Framing: At vertical joints, provide 1-1/2-by-3-5/8-inch (38-by-89-mm) steel channel support posts formed from 0.040-inch (1.0-mm) galvanized steel.
  - b. Joint Treatment Materials: Provide joint treatment compounds and reinforcing tape complying with requirements in Division 9 Section "Gypsum Board."
- 2. Snap-Together Type: Form column covers to shapes indicated from metal of type and minimum thickness indicated below. Return vertical edges and bend to form hook that will engage continuous mounting clips.
  - a. Aluminum Sheet: 0.063 inch (1.60 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
    - 1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
  - b. Steel Sheet: 0.060 inch (1.52 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
    - 1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
  - c. Stainless-Steel Sheet: 0.050 inch (1.27 mm) **OR** Thickness required to comply with performance requirements, **as directed**.



- 1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.
  - d. Bronze Sheet: 0.051 inch (1.29 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
    - 1) Finish: Buffed finish, lacquered **OR** Hand-rubbed finish, lacquered **OR** Statuary conversion coating over satin finish, **as directed**.
  - e. Brass Sheet: 0.051 inch (1.29 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
    - 1) Finish: Buffed **OR** Hand-rubbed, **as directed**, finish, lacquered.
  - f. Column covers may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.
  - g. Form returns at vertical joints to provide hairline V-joints.  
**OR**  
Form returns at vertical joints to provide 1/2-inch- (12-mm-) **OR** 3/4-inch- (18-mm-), **as directed**, wide reveal at joints. Provide snap-in metal filler strips at reveals that leave reveals 1/2 inch (12 mm) deep **OR** flush, **as directed**.  
**OR**  
Form returns at vertical joints to accommodate backer rod and sealant.
  - h. Fabricate column covers with hairline horizontal V-joints produced by forming returns on mating ends of column cover sections. Locate horizontal joints as indicated.  
**OR**  
Fabricate column covers without horizontal joints.  
**OR**  
Fabricate column covers with horizontal butt joints, tightly fitted and backed with a sleeve for field splicing with adhesive.  
**OR**  
Fabricate column covers with 1/2-inch- (12-mm-) wide, **as directed**, reveals at horizontal joints produced by forming returns on mating ends of column cover sections. Provide snap-in metal filler strips at reveals matching reveals at vertical joints. Locate horizontal joints as indicated.
  - i. Fabricate base **OR** ceiling, **as directed**, ring to match **OR** contrast with, **as directed**, column covers.
  - j. Fabricate with calk stop/stiffener ring.
  - k. Apply manufacturer's recommended sound-deadening insulation **OR** mastic, **as directed**, to backs of column covers.
- H. Decorative-Metal-Clad Doors And Frames
  - 1. Laminate metal sheets, of type and thickness indicated below, to faces of hollow-metal doors and frames and elevator entrances where indicated:
    - a. Bronze Sheet: 0.040 inch (1.02 mm).
      - 1) Finish: Buffed finish, lacquered **OR** Hand-rubbed finish, lacquered **OR** Statuary conversion coating over satin finish, lacquered, **as directed**.
    - b. Brass Sheet: 0.040 inch (1.02 mm).
      - 1) Finish: Buffed **OR** Hand-rubbed, **as directed**, finish lacquered.
    - c. Stainless-Steel Sheet: 0.038 inch (0.95 mm).
      - 1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.
    - d. Titanium Sheet: 0.025 inch (0.64 mm).
      - 1) Finish: Dull **OR** Bright, **as directed**, matte.
- I. Escalator Enclosures
  - 1. Form escalator enclosures from metal of type and thickness indicated below. Coordinate size of enclosures, location of cutouts, and method of attachment to adjoining construction.
    - a. Stainless-Steel Sheet: 0.062 inch (1.59 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
      - 1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.
    - b. Bronze Sheet: 0.081 inch (2.05 mm) **OR** Thickness required to comply with performance requirements, **as directed**.



- 1) Finish: Buffed finish, lacquered **OR** Hand-rubbed finish, lacquered **OR** Statuary conversion coating over satin finish, **as directed**.

#### J. Filler Panels

1. Form filler panels for closing ends of partition systems and for other applications indicated. Form from two sheets of metal of type and thickness indicated below, separated by channels formed from the same material, producing a panel of same thickness as partitions **OR** mullions, **as directed**, unless otherwise indicated. Incorporate reveals, trim, and concealed anchorages for attaching to adjacent surfaces.
  - a. Galvanized-Steel Sheet: 0.064 inch (1.63 mm).
    - 1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
  - b. Steel Sheet: 0.060 inch (1.52 mm).
    - 1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
  - c. Filler panels may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.
2. Fill interior of panel with sound-deadening insulation permanently attached to inside panel faces.
3. Adhesively attach gaskets to filler panel edges where they abut mullions or glazing. Use 1-inch- (25-mm-) square material, unless otherwise indicated, set approximately 1/4 inch (6 mm) into channeled edge of filler panel.
 

**OR**

Attach gaskets to all edges of panels that abut adjacent surfaces to form a continuous seal. Use compressible gaskets or mastic sealing tape, applied to center of panel edges to be concealed from view, unless otherwise indicated.
4. Do not mechanically fasten filler panels to mullions.

#### K. Heating-Cooling Unit Enclosures

1. Fabricate heating-cooling unit enclosures from metal of type and thickness indicated below:
  - a. Galvanized-Steel Sheet:
    - 1) Framing: 0.108 inch (2.74 mm) **OR** Thickness required to comply with performance requirements.
    - 2) Sills and Stools: 0.079 inch (2.01 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
    - 3) Front Panels and Bases: 0.064 inch (1.63 mm).
    - 4) Concealed Panels and Trim: 0.040 inch (1.02 mm).
    - 5) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
  - b. Steel Sheet:
    - 1) Framing: 0.105 inch (2.66 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
    - 2) Sills and Stools: 0.075 inch (1.90 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
    - 3) Front Panels and Bases: 0.060 inch (1.52 mm).
    - 4) Concealed Panels and Trim: 0.036 inch (0.91 mm).
    - 5) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
2. Weld seams and connections unless otherwise indicated or unless other methods are necessary for access to heating and cooling equipment.
3. Incorporate stiffeners or laminated backing using noncombustible materials as needed for strength and rigidity.
  - a. Fill space between stiffeners with sound-deadening insulation attached to face sheet with insulation adhesive unless otherwise indicated.
 

**OR**

Coat concealed faces of metal panels more than 6 inches (150 mm) wide with a heavy coating of sound-deadening mastic applied at the minimum rate of 20 sq. ft./gal. (0.5 sq. m/L).



4. Provide louvers and grilles of size, type, and materials indicated.
    - a. For removable grilles, use modular units with recessed openings formed into surfaces of enclosures and without blank filler panels between grilles, so face panels and stools are continuous. Fabricate removable grilles and openings to precise tolerances to produce well-fitted assemblies free of warp or rattle, with grilles supported continuously along parallel edges and with tops flush with top of enclosure.
  5. Incorporate removable tops and fronts where indicated or needed for access to heating-cooling units and to piping, ductwork, controls, and electrical service, with panels and openings as follows:
    - a. Fabricate with a fitting tolerance of not less than 1/32 inch (0.8 mm) and not more than 1/16 inch (1.6 mm) at each edge, with face of panels flush with adjoining fixed surfaces of enclosure.
    - b. Form panels for easy removal without interfering with adjoining construction or furniture. Hold panels in place with concealed clips and hardware that prevent warp and rattle.
  6. Incorporate hinged access panels in enclosures for access to heating-cooling unit controls, as either separate elements or integrated with grille openings, as indicated or needed.
  7. Coordinate construction, configuration, and dimensions of enclosures with those of heating-cooling units. Provide support for heating-cooling units and controls where indicated. Provide blind knockouts and supports for piping, ductwork, control lines, electrical conduit, and wiring where indicated or needed.
  8. Locate fixed surfaces of enclosure to coincide precisely with window mullions and partition system terminations. Provide closures at ends of units, at recessed openings in base of units, and at other locations where needed to conceal unfinished wall or floor surfaces, piping, conduit, ductwork, or heating-cooling units.
    - a. Provide built-in partitions (bulkheads) within enclosures between heating-cooling units, located to coincide with mullions and partition system terminations. Seal partitions to faces of enclosures with compressible gaskets or mastic sealing tape, and cover both sides of partitions with sound-deadening insulation attached to partitions with insulation adhesive.
- L. Lighting Coves
1. Form lighting coves from metal of type and thickness indicated below. Coordinate size of coves, location of cutouts for electrical wiring, and method of attachment to adjoining construction.
    - a. Aluminum Sheet: 0.063 inch (1.60 mm).
      - 1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
    - b. Galvanized-Steel Sheet: 0.052 inch (1.32 mm).
      - 1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
    - c. Steel Sheet: 0.048 inch (1.21 mm).
      - 1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
    - d. Fabricate light coves with hairline butt joints **OR** tapered edges for taping and spackling, **as directed**.
    - e. Provide mitered corners, factory welded with backplates **OR** factory endcaps, **as directed**.
    - f. Lighting coves may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.
- M. Metal Base
1. Form metal base from metal of type and thickness indicated below:
    - a. Aluminum Sheet: 0.063 inch (1.60 mm).
      - 1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
    - b. Stainless-Steel Sheet: 0.050 inch (1.27 mm).
      - 1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.

**N. Mullion Cladding**

1. Form mullion cladding from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction.
  - a. Aluminum Sheet: 0.063 inch (1.60 mm).
    - 1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
  - b. Galvanized-Steel Sheet: 0.052 inch (1.32 mm).
    - 1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
  - c. Stainless-Steel Sheet: 0.050 inch (1.27 mm).
    - 1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.

**O. Pipe System Covers**

1. Form pipe system covers from metal of type and thickness indicated below. Coordinate size of covers, location of cutouts for piping, and method of attachment to adjoining construction.
  - a. Galvanized-Steel Sheet: 0.052 inch (1.32 mm).
    - 1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
  - b. Steel Sheet: 0.048 inch (1.21 mm).
    - 1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.

**P. Pockets For Window Treatment**

1. Form pockets from metal of type and thickness indicated below, with end closures. Coordinate dimensions and attachment methods with window treatment equipment, window frames, ceiling suspension system, and other related construction to produce a coordinated, closely fitting assembly.
  - a. Aluminum Sheet: 0.063 inch (1.60 mm).
    - 1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
  - b. Galvanized-Steel Sheet: 0.052 inch (1.32 mm).
    - 1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
  - c. Steel Sheet: 0.048 inch (1.21 mm).
    - 1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
  - d. Pockets for window treatment may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.
2. Reinforce pockets for attaching window treatment equipment and hardware, or increase metal thickness.
3. Divide continuous pockets with built-in partitions located to separate adjoining drapery and blind units, to coincide with window mullions, and to receive filler panels at ends of partitions.

**Q. Window Stools**

1. Form window stools from metal of type and thickness indicated below, with end closures:
  - a. Aluminum Sheet: 0.063 inch (1.60 mm).
    - 1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
  - b. Galvanized-Steel Sheet: 0.052 inch (1.32 mm).
    - 1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
  - c. Stainless-Steel Sheet: 0.050 inch (1.27 mm) **OR** 1.3 mm, **as directed**.
    - 1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.
  - d. Bronze Sheet: 0.051 inch (1.29 mm).



- 1) Finish: Buffed finish, lacquered **OR** Hand-rubbed finish, lacquered **OR** Statuary conversion coating over satin finish, **as directed**.
  2. Weld seams at end closures.  
**OR**  
Braze seams at end closures.
  3. Apply sound-deadening insulation **OR** mastic, **as directed**, to underside of window stools.
- R. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  2. Complete mechanical finishes of flat sheet metal surfaces before fabrication where possible. After fabrication, finish all joints, bends, abrasions, and other surface blemishes to match sheet finish.
  3. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
  4. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
  5. Finish items indicated on Drawings after assembly.
  6. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- S. Aluminum Finishes
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
  2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
  3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
    - a. Color: Champagne **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.
  4. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
    - a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
  5. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
    - a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
  6. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    - a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

**OR**

High-Performance Organic Finish: Three **OR** Four, **as directed**, -coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    - b. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.



T. Galvanized-Steel Sheet Finishes

1. Preparing Galvanized Items for Factory Priming: Thoroughly clean galvanized decorative formed metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
2. Preparing Galvanized Items for Factory Finishing: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.
3. Repairing Galvanized Surfaces: Clean welds and abraded areas and repair galvanizing to comply with ASTM A 780.
4. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
5. Factory-Painted Finish: Comply with Division 09 Section(s) "Exterior Painting" OR "High-performance Coatings", **as directed**.
  - a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
  - a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
7. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm). Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.
  - a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
8. Siliconized-Polyester Coating: Immediately after cleaning and pretreating, apply manufacturer's standard epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
  - a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
9. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

**OR**

High-Performance Organic Finish: Three **OR** Four, **as directed**, -coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

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

U. Steel Sheet Finishes

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
2. Pretreatment: Immediately after cleaning, apply a conversion coating of type suited to organic coating applied over it.



3. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
4. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
  - a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
5. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm). Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.
  - a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

V. Stainless-Steel Finishes

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
  - a. Run grain of directional finishes with long dimension of each piece.
3. Bright, Cold-Rolled, Unpolished Finish: No. 2B.
4. Directional Satin Finish: No. 4.
5. Dull Satin Finish: No. 6.
6. Satin, Reflective, Directional Polish: No. 7.
7. Mirrorlike Reflective, Nondirectional Polish: No. 8 finish.
8. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

W. Copper-Alloy Finishes

1. Finish designations for copper alloys comply with the system established for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
2. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).
3. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).
4. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).
5. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).
6. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear organic, air drying, as specified below).
  - a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
7. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear organic, air drying, as specified below).
  - a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
8. Medium-Satin Finish, Lacquered: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below).
  - a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
9. Fine-Matte Finish, Lacquered: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear organic, air drying, as specified below).



- a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
10. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide), with color matching the Owner's sample.
11. Statuary Conversion Coating over Satin Finish, Lacquered: M31-C55-O6x (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide; Coating: clear, organic, air drying, as specified below) , with color matching the Owner's sample:
  - a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

#### X. Titanium Finishes

1. General: Fabricate items from finished titanium sheet, taking care not to damage finish during fabrication. Protect finish as needed during fabrication by applying a strippable, temporary protective covering.
2. Dull Matte Finish: Pickled and annealed.
3. Bright Matte Finish: Vacuum annealed.

### 1.3 EXECUTION

#### A. Examination

1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative formed metal.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### B. Installation

1. Locate and place decorative formed metal items level and plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install decorative formed metal.
  - a. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.
2. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where needed to protect metal surfaces and to make a weathertight connection.
3. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.
4. Install concealed gaskets, joint fillers, insulation, sealants, and flashings, as the Work progresses, to make exterior decorative formed metal items weatherproof.
5. Install concealed gaskets, joint fillers, sealants, and insulation, as the Work progresses, to make interior decorative formed metal items soundproof or lightproof as applicable to type of fabrication indicated.
6. Corrosion Protection: Apply bituminous paint or other permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with substrate materials that are incompatible or could result in corrosion or deterioration of either material or finish.
7. Install decorative-formed-metal-clad doors and frames to comply with requirements specified in Division 08 Section "Hollow Metal Doors And Frames".
8. Apply joint treatment at joints of spackled-seam-type metal column covers. Comply with requirements in Division 09 Section "Gypsum Board".

#### C. Adjusting And Cleaning

1. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.



2. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.
  3. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
    - a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
  4. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
  5. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.
- D. Protection
1. Protect finishes of decorative formed metal items from damage during construction period. Remove temporary protective coverings at time of Final Completion.

END OF SECTION 05 75 00 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
05 75 00 00	05 73 00 00	Ornamental Metal
05 75 00 00	05 73 00 00a	Miscellaneous Ornamental Metals



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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: 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).
  - a. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
  - b. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.



2. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
  3. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
    - a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
  4. Application: Treat all miscellaneous carpentry, unless otherwise indicated **OR** items indicated on Drawings, and the following, **as directed**:
    - a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
    - b. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
    - c. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
    - d. Wood framing members that are less than 18 inches (460 mm) above the ground in crawl spaces or unexcavated areas.
    - e. Wood floor plates that are installed over concrete slabs-on-grade.
- C. Fire-Retardant-Treated Materials
1. General: Comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood).
    - a. Use treatment that does not promote corrosion of metal fasteners.
    - b. Use Exterior type for exterior locations and where indicated.
    - c. Use Interior Type A, High Temperature (HT) for enclosed roof framing, framing in attic spaces, and where indicated.
    - d. Use Interior Type A, unless otherwise indicated.
  2. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
    - a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
  3. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
  4. Application: Treat all miscellaneous carpentry, unless otherwise indicated **OR** items indicated on Drawings, and the following, **as directed**:
    - a. Framing for raised platforms.
    - b. Concealed blocking.
    - c. Roof construction.
    - d. Plywood backing panels.
- D. Dimension Lumber Framing
1. Maximum Moisture Content: 15 percent **OR** 19 percent **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less, 19 percent for more than 2-inch nominal (38-mm actual) thickness, **as directed**.
  2. Non-Load-Bearing Interior Partitions: Construction or No. 2 **OR** Construction, Stud, or No. 3 **OR** Standard, Stud, or No. 3, **as directed**, grade of any species.
  3. Other Framing: No. 2 **OR** Construction or No. 2 **OR** Construction, Stud, or No., **as directed**, grade and any of the following species:
    - a. Hem-fir (north); NLGA.
    - b. Southern pine; SPIB.
    - c. Douglas fir-larch; WCLIB or WWPA.
    - d. Mixed southern pine; SPIB.
    - e. Spruce-pine-fir; NLGA.
    - f. Douglas fir-south; WWPA.
    - g. Hem-fir; WCLIB or WWPA.



- h. Douglas fir-larch (north); NLGA.
- i. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

#### E. Miscellaneous Lumber

1. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
  - a. Blocking.
  - b. Nailers.
  - c. Rooftop equipment bases and support curbs.
  - d. Cants.
  - e. Furring.
  - f. Grounds.
  - g. Utility shelving.
2. For items of dimension lumber size, provide Construction or No. 2 **OR** Standard, Stud, or No. 3, **as directed**, grade lumber with 15 **OR** 19, **as directed**, percent maximum moisture content of any species.
3. For exposed boards, provide lumber with 15 **OR** 19, **as directed**, percent maximum moisture content and any of the following species and grades:
  - a. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Premium or 2 Common (Sterling) **OR** Standard or No. 3 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
  - b. Mixed southern pine, No. 1 **OR** 2, **as directed**, grade; SPIB.
  - c. Hem-fir or hem-fir (north), Select Merchantable or No. 1 Common **OR** Construction or No. 2 Common, **as directed**, grade; NLGA, WCLIB, or WWPA.
  - d. Spruce-pine-fir (south) or spruce-pine-fir, Select Merchantable or No. 1 Common **OR** Construction or No. 2 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
4. For concealed boards, provide lumber with 15 **OR** 19, **as directed**, percent maximum moisture content and any of the following species and grades:
  - a. Mixed southern pine, No. 2 **OR** 3, **as directed**, grade; SPIB.
  - b. Hem-fir or hem-fir (north), Construction or 2 Common **OR** Standard or 3 Common, **as directed**, grade; NLGA, WCLIB, or WWPA.
  - c. Spruce-pine-fir (south) or spruce-pine-fir, Construction or 2 Common **OR** Standard or 3 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
  - d. Eastern softwoods, No. 2 **OR** 3, **as directed**, Common grade; NELMA.
  - e. Northern species, No. 2 **OR** 3, **as directed**, Common grade; NLGA.
  - f. Western woods, Construction or No. 2 Common **OR** Standard or No. 3 Common, **as directed**, grade; WCLIB or WWPA.
5. For blocking not used for attachment of other construction Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
6. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
7. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

#### F. Interior Wood Trim

1. General: Provide kiln-dried finished (surfaced) material without finger-jointing, unless otherwise indicated.
2. Softwood Lumber Trim for Transparent (Stain or Clear) Finish: Provide one of the following species and grade:
  - a. Grade C Select **OR** D Select **OR** Finish **OR** Premium, **as directed**, eastern white pine; NeLMA or NLGA.
  - b. Grade C Select (Choice) **OR** D Select (Quality) **OR** 1 Common (Colonial) **OR** 2 Common (Sterling), **as directed**, Idaho white, lodgepole, ponderosa, or sugar pine; NLGA or WWPA.



- c. Grade Superior or C & Btr **OR** Prime or D, **as directed**, Finish Douglas fir-larch or Douglas fir-south; NLGA, WCLIB, or WWPA.
      - d. Clear Heart **OR** Grade A **OR** Grade B, **as directed**, western red cedar; NLGA, WCLIB, or WWPA.
    3. Hardwood Lumber Trim for Transparent (Stain or Clear) Finish: Clear red oak **OR** white maple, **as directed**, selected for compatible grain and color, **as directed**.
    4. Lumber Trim for Opaque (Painted) Finish: Either finger-jointed or solid lumber, of one of the following species and grades:
      - a. Grade D Select **OR** Finish **OR** Premium, **as directed**, eastern white pine; NeLMA or NLGA.
      - b. Grade D Select (Quality) **OR** 1 Common (Colonial) **OR** 2 Common (Sterling), **as directed**, Idaho white, lodgepole, ponderosa, or sugar pine; NLGA or WWPA.
      - c. Grade A **OR** B, **as directed**, Finish aspen, basswood, cottonwood, gum, magnolia, red alder, soft maple, sycamore, tupelo, or yellow poplar; NHLA.
    5. Moldings: Made to patterns included in WMMPA WM 7 and graded according to WMMPA WM 4.
      - a. Moldings for Transparent (Stain or Clear) Finish: N-grade eastern white, Idaho white, lodgepole, ponderosa, or sugar pine **OR** western red cedar **OR** Douglas fir **OR** red oak **OR** white maple, **as directed**, selected for compatible grain and color.
      - b. Moldings for Opaque (Painted) Finish: P-grade eastern white, Idaho white, lodgepole, ponderosa, or sugar pine **OR** aspen, basswood, cottonwood, gum, magnolia, soft maple, tupelo, or yellow poplar **OR** primed medium-density fiberboard, **as directed**.
- G. Shelving And Clothes Rods
  1. Shelving: Made from one of the following materials, 3/4-inch (19-mm) thick. Do not use particleboard or medium-density fiberboard that contains urea formaldehyde.
    - a. Melamine-faced particleboard with radiused and filled front edge.
    - b. Particleboard with radiused and filled **OR** solid-wood, **as directed**, front edge.
    - c. Medium-density fiberboard with radiused **OR** solid-wood, **as directed**, front edge.
    - d. Wood boards of same species and grade indicated above for interior lumber trim for opaque **OR** transparent, **as directed**, finish.
  2. Shelf Cleats: 3/4-by-3-1/2-inch (19-by-89-mm) boards **OR** 3/4-by-5-1/2-inch (19-by-140-mm) boards with hole and notch to receive clothes rods, **as directed**, of same species and grade indicated above for interior lumber trim for opaque finish.
  3. Shelf Brackets: Prime-painted formed steel with provision to support clothes rod where rod is indicated.
  4. Clothes Rods:
    - a. 1-1/2-inch- (38-mm-) diameter, clear, kiln-dried hardwood rods **OR** clear, kiln-dried softwood rods; either Douglas fir or southern pine **OR** aluminum tubes, **as directed**.  
**OR**  
1-1/4-inch- (32-mm-) diameter, chrome-plated steel **OR** stainless-steel, **as directed**, tubes.
  5. Rod Flanges: Clear, kiln-dried hardwood turnings **OR** Clear, kiln-dried softwood turnings **OR** Aluminum **OR** Chrome-plated steel **OR** Stainless steel, **as directed**.
- H. Plywood Backing Panels
  1. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, **as directed**, in thickness indicated or, if not indicated, not less than 1/2-inch (13-mm) nominal thickness.
- I. Fasteners
  1. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
    - a. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M **OR** of Type 304 stainless steel, **as directed**.
  2. Nails, Brads, and Staples: ASTM F 1667.
  3. Power-Driven Fasteners: NES NER-272.



4. Wood Screws: ASME B18.6.1.
  5. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
  6. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
  7. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
  8. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
    - a. Material:
      - 1) Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.  
**OR**  
Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).
- J. Metal Framing Anchors
1. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
    - a. Use for interior locations where stainless steel is not indicated.
  2. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** 316, **as directed**.
    - a. Use for exterior locations and where indicated.
- K. Miscellaneous Materials
1. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
    - a. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

### 1.3 EXECUTION

#### A. Installation, General

1. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
2. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.
3. Metal Framing Anchors: Install metal framing to comply with manufacturer's written instructions.
4. Do not splice structural members between supports, unless otherwise indicated.
5. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
  - a. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.
6. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
  - a. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
  - b. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches (2438 mm) o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal- (38-mm actual-) thickness.



- c. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. (9.3 sq. m) and to solidly fill space below partitions.
  - d. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet (6 m) o.c.
  7. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
  8. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
    - a. Use inorganic boron for items that are continuously protected from liquid water.
    - b. Use copper naphthenate for items not continuously protected from liquid water.
  9. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
    - a. NES NER-272 for power-driven fasteners.
    - b. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
    - c. "Nailing Schedule," and Tables in Section 2304 of the ICC's International Building Code.
    - d. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
    - e. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
    - f. Table 602.3(1), "Fastener Schedule for Structural Members," and Table 602.3(2), "Alternate Attachments," in ICC's International One- and Two-Family Dwelling Code.
  10. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.
- B. Wood Ground, Sleeper, Blocking, And Nailers 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 AWWA C15 requirements for "sawn building poles and posts as structural members."
  - a. Timber that is not in contact with the ground and is continuously protected from liquid water may be treated with inorganic boron (SBX) according to AWWA C31 instead of AWWA C15.
  - b. Treatment with CCA shall include post-treatment fixation process.
2. Pressure treat poles with waterborne preservative to comply with AWWA C4.
  - a. Treatment with CCA shall include post-treatment fixation process.
3. Preservative Chemicals: Acceptable to authorities having jurisdiction.
  - a. Do not use chemicals containing arsenic or chromium except for marine (saltwater) applications.
4. Use process that includes water-repellent treatment.
5. Use process that does not include water repellents or other substances that might interfere with application of indicated finishes.
6. After treatment, redry timber and poles to 19 percent maximum moisture content.
7. Mark treated timber and poles with treatment quality mark of an inspection agency approved by ALSC's Board of Review.
  - a. For exposed items indicated to receive a stained or natural finish, mark each piece on surface that will not be exposed or omit marking and provide certificates of treatment compliance issued by inspection agency.
8. Application: Treat all heavy timber construction unless otherwise indicated **OR** Treat items indicated on Drawings and the following, **as directed**:
  - a. Sills and similar members in contact with masonry or concrete.
  - b. Timber framing members less than 18 inches (460 mm) above grade.

### D. Timber Connectors

1. General: Unless otherwise indicated, fabricate from the following materials:



- a. Structural-steel shapes, plates, and flat bars complying with ASTM A 36/A 36M.
  - b. Round steel bars complying with ASTM A 575, Grade M 1020.
  - c. Hot-rolled steel sheet complying with ASTM A 1011/A 1011M, Structural Steel, Type SS, Grade 33.
  - d. Stainless-steel plate and flat bars complying with ASTM A 666, Type 304 **OR** Type 316, **as directed**.
  - e. Stainless-steel bars and shapes complying with ASTM A 276, Type 304 **OR** Type 316, **as directed**.
  - f. Stainless-steel sheet complying with ASTM A 666, Type 304 **OR** Type 316, **as directed**.
2. Fabricate beam seats from steel **OR** stainless steel, **as directed**, with 0.239-inch (6-mm) **OR** 3/16-inch (8-mm) **OR** 3/8-inch (9.5-mm), **as directed**, bearing plates, 3/4-inch- (19-mm-) diameter-by-12-inch- (300-mm-) long deformed bar anchors, and 0.239-inch (6-mm) side plates.
  3. Fabricate beam hangers from steel **OR** stainless steel, **as directed**, with 0.179-inch (4.6-mm) stirrups and 0.239-inch (6-mm) top plates.
  4. Fabricate strap ties from steel **OR** stainless steel, **as directed**, 2-1/2 inches (63 mm) wide by 0.179 inch (4.6 mm) **OR** 3 inches (75 mm) wide by 0.239 inch (6 mm), **as directed**, thick.
  5. Fabricate tie rods from round steel bars with upset threads connected with forged-steel turnbuckles complying with ASTM A 668/A 668M.
  6. Provide bolts, 3/4 inch (19 mm) unless otherwise indicated, complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); provide nuts complying with ASTM A 563 (ASTM A 563M); and, where indicated, provide flat washers.
  7. Provide shear plates, 2-5/8 inches (66.7 mm) **OR** 4 inches (102 mm), **as directed**, in diameter, complying with ASTM D 5933.
  8. Finish steel assemblies and fasteners with rust-inhibitive primer, 2-mil (0.05-mm) dry film thickness.
  9. Hot-dip galvanize steel assemblies and fasteners after fabrication to comply with ASTM A 123/A 123M or ASTM A 153/A 153M.

#### E. Fabrication

1. Camber: Fabricate horizontal members and inclined members with a slope of less than 1:1, with natural convex bow (crown) up, to provide camber.
2. Shop fabricate members by cutting and restoring exposed surfaces to match specified surfacing. Finish exposed surfaces to remove planing or surfacing marks, and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.
3. Pre-drill 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 AWPA M4.
  - 1) Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
  - 2) Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.
4. Install timber connectors as indicated.
  - a. Unless otherwise indicated, install bolts with same orientation within each connection and in similar connections.
  - b. Install bolts with orientation as indicated or, if not indicated, as directed by the Owner.

**B. Adjusting**

1. Repair damaged surfaces and finishes after completing erection. Replace damaged heavy timber construction if repairs are not approved by the Owner.

END OF SECTION 06 05 23 00b



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
06 05 23 00	06 10 00 00	Rough Carpentry
06 05 73 13	01 22 16 00	No Specification Required



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## SECTION 06 05 73 33 - WOOD DECKING

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. Section Includes:
  - a. Solid-sawn wood roof and floor decking.
  - b. Glued-laminated wood roof and floor decking.

#### C. Submittals

1. Product Data: For each type of product indicated.
  - a. For glued-laminated wood decking, include installation instructions and data on lumber, adhesives, and fabrication.
  - b. For preservative-treated wood products, include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
2. LEED Submittals:
  - a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood used for decking complies with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
    - 1) Include statement indicating costs for each certified wood product.
  - b. Product Data for Credit EQ 4.1: For sealants and installation adhesives, including printed statement of VOC content.
  - c. Product Data for Credit EQ 4.4: For laminating adhesive used for glued-laminated decking, indicating that product contains no urea formaldehyde.

#### D. Quality Assurance

1. Standard for Solid-Sawn Wood Decking: Comply with AITC 112.
2. Forest Certification: Provide wood decking produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

#### E. Delivery, Storage, And Handling

1. Schedule delivery of wood decking to avoid extended on-site storage and to avoid delaying the Work.
2. Store materials under cover and protected from weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings. Stack wood decking with surfaces that are to be exposed in the final Work protected from exposure to sunlight.

### 1.2 PRODUCTS

#### A. Wood Decking, General

1. General: Comply with DOC PS 20 and with applicable grading rules of inspection agencies certified by ALSC's Board of Review.
2. Moisture Content: Provide wood decking with 15 **OR** 19, **as directed**, percent maximum moisture content at time of dressing.



B. Solid-Sawn Wood Decking

1. Decking Species: Alaska cedar **OR** Balsam fir **OR** Douglas fir-larch or Douglas fir-larch (North) **OR** Eastern spruce **OR** Hem-fir or hem-fir (North) **OR** Southern pine, **as directed**.
2. Decking Nominal Size: 2x6 **OR** 2x8 **OR** 3x6 **OR** 4x6, **as directed**.
3. Decking Grade:
  - a. Select(ed) **OR** Commercial, **as directed**, Decking.  
**OR**  
Dense Standard **OR** Dense Select **OR** Select **OR** Dense Commercial **OR** Commercial, **as directed**, Decking.  
**OR**  
Select(ed) Decking or Select Dex **OR** Commercial Decking or Commercial Dex, **as directed**.
4. Grade Stamps: Factory mark each item with grade stamp of grading agency. Apply grade stamp to surfaces that will not be exposed to view.
5. Face Surface: Rough sanded or wire brushed **OR** Saw textured **OR** Smooth, **as directed**.
6. Edge Pattern: Beaded edge **OR** Bullnosed **OR** Channel grooved **OR** Vee grooved, **as directed**.
7. Preservative Treatment: Pressure treat solid-sawn wood decking according to AWPAC31 with inorganic boron (SBX) and redry wood to 15 **OR** 19, **as directed**, percent maximum moisture content.

C. Glued-Laminated Wood Decking

1. Face Species: Alaska cedar **OR** Douglas fir-larch or Douglas fir-larch (North) **OR** Ponderosa pine **OR** Southern pine **OR** Western cedars or western cedars (North), **as directed**.
2. Decking Nominal Size: 2x6 **OR** 2x8 **OR** 3x6 **OR** 3x8 **OR** 4x6 **OR** 4x8 **OR** 5x6 **OR** 5x8, **as directed**.
3. Decking Configuration: For glued-laminated wood decking indicated to be of diaphragm design and construction, provide tongue-and-groove configuration that complies with research/evaluation report.
4. Face Grade:
  - a. Custom or Supreme: Clear face is required. Occasional pieces may contain a small knot or minor characteristic that does not detract from the overall appearance.  
**OR**  
Decorative: Sound knots and natural characteristics are allowed, including chipped edge knots, short end splits, seasoning checks, and some pin holes. Face knot holes, stain, end slits, skip, roller split, and planer burn are not allowed.  
**OR**  
Service: Face knot holes, stain, end splits, skip, roller split, planer burn, and other nonstrength-reducing characteristics are allowed. Strength-reducing characteristics are not allowed.
5. Face Surface: Rough sanded or wire brushed **OR** Saw textured **OR** Smooth, **as directed**.
6. Edge Pattern: Beaded edge **OR** Bullnosed **OR** Channel grooved **OR** Vee grooved, **as directed**.
7. Laminating Adhesive: Wet-use type complying with ASTM D 2559.
  - a. Use adhesive that contains no urea-formaldehyde resins.
8. Preservative Treatment: Pressure treat lumber before gluing according to AWPAC28 for aboveground use.
  - a. Use oxine copper (copper-8-quinolinolate) in a light petroleum solvent.  
**OR**  
Use copper naphthenate in a light petroleum solvent.  
**OR**  
Use waterborne preservative that is acceptable to authorities having jurisdiction and that contains no arsenic or chromium. After treating, redry wood to 15 **OR** 19, **as directed**, percent maximum moisture content.  
**OR**  
Use preservative solution without water repellents or substances that might interfere with application of indicated finishes.

**OR**

After dressing and fabricating decking, apply copper naphthenate according to AWPA M4 to surfaces cut to a depth of more than 1/16 inch (1.5 mm).

**D. Accessory Materials**

1. Fasteners for Solid-Sawn Decking: Provide fastener size and type complying with decking standard for thickness of deck used.
2. Fasteners for Glued-Laminated Decking: Provide fastener size and type complying with requirements in "Installation" Article for installing laminated decking.
3. Nails: Common; complying with ASTM F 1667, Type I, Style 10.
4. Spikes: Round; complying with ASTM F 1667, Type III, Style 3.
5. Fastener Material: Hot-dip galvanized **OR** Stainless, **as directed**, steel.
6. Bolts for Anchoring Decking to Walls:
  - a. Carbon steel; complying with ASTM A 307 (ASTM F 568M) with ASTM A 563/A 563M hex nuts and, where indicated, flat washers, all hot-dip zinc coated, **as directed**.

**OR**

Stainless steel; complying with ASTM F 593, Alloy Group 1 or 2 (ASTM F 738M, Grade A1 or A4); with ASTM F 594, Alloy Group 1 or 2 (ASTM F 836M, Grade A1 or A4) hex nuts and, where indicated, flat washers.

7. Installation Adhesive: For glued-laminated wood decking indicated to be of diaphragm design and construction, provide adhesive that complies with research/evaluation report.
  - a. Use adhesive that has a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Sealant: Latex sealant compatible with substrates **OR** Elastomeric joint sealant complying with requirements in Division 07 Section "Joint Sealants" for Use NT (nontraffic) and for Uses M, G, A, and, as applicable to joint substrates indicated, O joint substrates, **as directed**.
  - a. Use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. Penetrating Sealer: Clear sanding sealer complying with Division 09 Section "Staining And Transparent Finishing" and compatible with topcoats specified for use over it.

**E. Fabrication**

1. Shop Fabrication: Where preservative-treated decking is indicated, complete cutting, trimming, surfacing, and sanding before treating.
2. Predrill decking for lateral spiking to adjacent units to comply with referenced decking standard.
3. Seal Coat: After fabricating and surfacing decking, apply a saturation coat of penetrating sealer in fabrication shop, **as directed**.

**1.3 EXECUTION****A. Installation**

1. Install solid-sawn wood decking to comply with referenced decking standard.
  - a. Locate end joints for two-span continuous lay-up **OR** combination simple and two-span continuous lay-up **OR** controlled random lay-up **OR** lay-up indicated, **as directed**.
2. Install laminated wood decking to comply with manufacturer's written instructions.
  - a. Locate end joints for two-span continuous lay-up **OR** combination simple and two-span continuous lay-up **OR** controlled random lay-up **OR** lay-up indicated, **as directed**.
  - b. Nail each course of glued-laminated wood decking at each support with one nail slant nailed above the tongue and one nail straight nailed through the face.
    - 1) Use 12d nails for 2x6 and 2x8 decking.
    - 2) Use 30d nails for 3x6 and 3x8 decking.
    - 3) Use 60d nails for 4x6 and 4x8 decking. Predrill decking to prevent splitting.
    - 4) Use 30d tongue nails in bottom tongue and 3/8-inch (10-mm) face spikes for 5x6 and 5x8 decking. Predrill decking at spikes to prevent splitting.



- c. Slant nail each course of glued-laminated wood decking to the tongue of the adjacent course at 30 inches (750 mm) o.c. and within 12 inches (300 mm) of the end of each unit. Stagger nailing in adjacent courses 15 inches (380 mm).
    - 1) Use 6d nails for 2x6 and 2x8 decking.
    - 2) Use 8d nails for 3x6 and 3x8 decking.
    - 3) Use 10d nails for 4x6 and 4x8 decking.
    - 4) Use 16d nails for 5x6 and 5x8 decking.
  - d. Glue adjoining decking courses together by applying a 3/8-inch (10-mm) bead of adhesive on the top of tongues according to research/evaluation report.
3. Anchor wood roof decking, where supported on walls, with bolts as indicated.
  4. Where preservative-treated decking must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.
    - a. For solid-sawn decking, use inorganic boron (SBX).
    - b. For laminated decking, use copper naphthenate.
  5. Apply joint sealant to seal roof decking at exterior walls at the following locations:
    - a. Between decking and supports located at exterior walls.
    - b. Between decking and exterior walls that butt against underside of decking.
    - c. Between tongues and grooves of decking over exterior walls and supports at exterior walls.
- B. Adjusting
1. Repair damaged surfaces and finishes after completing erection. Replace damaged decking if repairs are not approved by the Owner.
- C. Protection
1. Provide temporary waterproof covering as the Work progresses to protect roof decking until roofing is applied.

END OF SECTION 06 05 73 33



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
06 05 73 33	06 05 23 00	Timber Bridge Components
06 05 73 33	06 10 00 00	Rough Carpentry
06 05 73 33	06 05 23 00a	Miscellaneous Carpentry
06 05 73 33	06 05 23 00b	Heavy Timber Construction



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**SECTION 06 10 00 00 - ROUGH CARPENTRY**

## 1.1 GENERAL

## A. Description Of Work:

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

## B. Summary

1. This Section includes the following:
  - a. Framing with dimension lumber.
  - b. Framing with timber.
  - c. Framing with engineered wood products.
  - d. Rooftop equipment bases and support curbs.
  - e. Wood blocking, cants, and nailers.
  - f. Wood furring and grounds.
  - g. Wood sleepers.
  - h. Utility shelving.
  - i. Plywood backing panels.

## C. Definitions

1. Exposed Framing: Framing not concealed by other construction.
2. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.
3. Timber: Lumber of 5 inches nominal (114 mm actual) or greater in least dimension.
4. Lumber grading agencies, and the abbreviations used to reference them, include the following:
  - a. NeLMA: Northeastern Lumber Manufacturers' Association.
  - b. NLGA: National Lumber Grades Authority.
  - c. RIS: Redwood Inspection Service.
  - d. SPIB: The Southern Pine Inspection Bureau.
  - e. WCLIB: West Coast Lumber Inspection Bureau.
  - f. WWPA: Western Wood Products Association.

## D. Submittals

1. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
  - a. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
  - b. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
  - c. For fire-retardant treatments specified to be High-Temperature (HT) type, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
  - d. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
  - e. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
2. LEED Submittals:



- a. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
- b. Product Data for Credit EQ 4.4: For composite-wood products, documentation indicating that product contains no urea formaldehyde.
- c. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
  - 1) Include statement indicating costs for each certified wood product.
3. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
4. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
  - a. Wood-preservative-treated wood.
  - b. Fire-retardant-treated wood.
  - c. Engineered wood products.
  - d. Power-driven fasteners.
  - e. Powder-actuated fasteners.
  - f. Expansion anchors.
  - g. Metal framing anchors.

#### E. Quality Assurance

1. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
  - a. Dimension lumber framing.
  - b. Timber.
  - c. Laminated-veneer lumber.
  - d. Parallel-strand lumber.
  - e. Prefabricated wood I-joists.
  - f. Rim boards.
  - g. Miscellaneous lumber.

#### F. Delivery, Storage, And Handling

1. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

## 1.2 PRODUCTS

#### A. Wood Products, General

1. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
  - a. Factory mark each piece of lumber with grade stamp of grading agency.
  - b. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
  - c. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
  - d. Provide dressed lumber, S4S, unless otherwise indicated.



2. Engineered Wood Products: Provide engineered wood products acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
    - a. Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
- B. Wood-Preservative-Treated Lumber
1. Preservative Treatment by Pressure Process: AWPA C2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX).
    - a. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
    - b. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
  2. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
  3. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
    - a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
  4. Application: Treat all rough carpentry, unless otherwise indicated, **OR** items indicated on Drawings, and the following, **as directed**:
    - a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
    - b. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
    - c. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
    - d. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
    - e. Wood floor plates that are installed over concrete slabs-on-grade.
- C. Fire-Retardant-Treated Materials
1. General: Comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood).
    - a. Use Exterior type for exterior locations and where indicated.
    - b. Use Interior Type A, High Temperature (HT) for enclosed roof framing, framing in attic spaces, and where indicated.
    - c. Use Interior Type A, unless otherwise indicated.
  2. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
    - a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
  3. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
  4. Application: Treat all rough carpentry, unless otherwise indicated, **OR** items indicated on Drawings, and the following, **as directed**:
    - a. Framing for raised platforms.
    - b. Concealed blocking.
    - c. Framing for non-load-bearing partitions.



- d. Framing for non-load-bearing exterior walls.
- e. Roof construction.
- f. Plywood backing panels.

D. Dimension Lumber Framing

1. Maximum Moisture Content: 15 percent **OR** 19 percent **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less, 19 percent for more than 2-inch nominal (38-mm actual) thickness **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less, no limit for more than 2-inch nominal (38-mm actual) thickness **OR** 19 percent for 2-inch nominal (38-mm actual) thickness or less, no limit for more than 2-inch nominal (38-mm actual) thickness, **as directed**.
2. Non-Load-Bearing Interior Partitions: Construction or No. 2 **OR** Construction, Stud, or No. 3 **OR** Standard, Stud, or No. 3, **as directed**, grade of any species.
3. Exterior and Load-Bearing Walls **OR** Framing Other Than Non-Load-Bearing Interior Partitions **OR** Framing Other Than Interior Partitions, **as directed**: Any species and grade with a modulus of elasticity of at least 1,500,000 psi (10 350 MPa) **OR** 1,300,000 psi (8970 MPa) **OR** 1,100,000 psi (7590 MPa) **OR** 1,000,000 psi (6900 MPa) **OR** 900,000 psi (6210 MPa), **as directed**, and an extreme fiber stress in bending of at least 1000 psi (6.9 MPa) **OR** 850 psi (5.86 MPa) **OR** 700 psi (4.83 MPa) **OR** 600 psi (4.14 MPa) **OR** 500 psi (3.45 MPa), **as directed**, for 2-inch nominal (38-mm actual) thickness and 12-inch nominal (286-mm actual) width for single-member use.
4. Ceiling Joists (Non-Load-Bearing): Construction or No. 2 **OR** Construction, Stud, or No. 3 **OR** Standard, Stud, or No. 3, **as directed**, grade of any species.
5. Joists, Rafters, and Other Framing Not Listed Above: Any species and grade with a modulus of elasticity of at least 1,500,000 psi (10 350 MPa) **OR** 1,300,000 psi (8970 MPa) **OR** 1,100,000 psi (7590 MPa) **OR** 1,000,000 psi (6900 MPa) **OR** 900,000 psi (6210 MPa), **as directed**, and an extreme fiber stress in bending of at least 1000 psi (6.9 MPa) **OR** 850 psi (5.86 MPa) **OR** 700 psi (4.83 MPa) **OR** 600 psi (4.14 MPa) **OR** 500 psi (3.45 MPa), **as directed**, for 2-inch nominal (38-mm actual) thickness and 12-inch nominal (286-mm actual) width for single-member use.
6. Exposed Exterior **OR** Interior, **as directed**, Framing Indicated to Receive a Stained or Natural Finish: Provide material hand-selected for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.
  - a. Species and Grade: As indicated above for load-bearing construction of same type.
  - b. Species and Grade: Hem-fir (north), Select Structural **OR** No. 1, **as directed**, grade; NLGA.
  - c. Species and Grade: Southern pine, Select Structural **OR** No. 1 **OR** No. 2, **as directed**, grade; SPIB.
  - d. Species and Grade: Douglas fir-larch; Select Structural **OR** No. 1, **as directed**, grade; WCLIB, or WWPA.
  - e. Species and Grade: Mixed southern pine, Select Structural **OR** No. 1 **OR** No. 2, **as directed**, grade; SPIB.
  - f. Species and Grade: Spruce-pine-fir, Select Structural **OR** No. 1, **as directed**, grade; NLGA.
  - g. Species and Grade: Douglas fir-south; Select Structural **OR** No. 1, **as directed**, grade; WWPA.
  - h. Species and Grade: Hem-fir; Select Structural **OR** No. 1, **as directed**, grade; WCLIB, or WWPA.
  - i. Species and Grade: Douglas fir-larch (north); Select Structural **OR** No. 1, **as directed**, grade; NLGA.
  - j. Species and Grade: Spruce-pine-fir (south), Select Structural **OR** No. 1, **as directed**, grade; NeLMA, WCLIB, or WWPA.
  - k. Species and Grade: Eastern hemlock-balsam fir or eastern hemlock-tamarack; Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
  - l. Species and Grade: Beech-birch-hickory, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.



- m. Species and Grade: Northern red oak, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
  - n. Species and Grade: Redwood, Clear Heart Structural **OR** Clear Structural **OR** Select Structural **OR** No. 1, **as directed**, grade; RIS.
  - o. Species and Grade: Mixed oak, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
  - p. Species and Grade: Mixed maple, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
  - q. Species and Grade: Western cedars, Select Structural **OR** No. 1, **as directed**, grade; WCLIB, or WWPA.
- E. Timber Framing
- 1. Provide timber framing complying with the following requirements, according to grading rules of grading agency indicated:
    - a. Species and Grade: Douglas fir-larch, Douglas fir-larch (north), or Douglas fir-south; Select Structural **OR** No. 1, **as directed**, grade; NLGA, WCLIB, or WWPA.
    - b. Species and Grade: Eastern hemlock, eastern hemlock-tamarack, or eastern hemlock-tamarack (north); Select Structural **OR** No. 1, **as directed**, grade; NeLMA or NLGA.
    - c. Species and Grade: Hem-fir or hem-fir (north), Select Structural **OR** No. 1, **as directed**, grade; NLGA, WCLIB, or WWPA.
    - d. Species and Grade: Mixed maple, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
    - e. Species and Grade: Mixed oak, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
    - f. Species and Grade: Southern pine, Select Structural **OR** No. 1, **as directed**, grade; SPIB.
    - g. Maximum Moisture Content: 20 **OR** 23, **as directed**, percent.
    - h. Additional Restriction: Free of heart centers.
- F. Engineered Wood Products
- 1. Laminated-Veneer Lumber: Structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559 and containing no urea formaldehyde.
    - a. Extreme Fiber Stress in Bending, Edgewise: 3100 psi (21.3 MPa) **OR** 2900 psi (20.0 MPa) **OR** 2600 psi (17.9 MPa) **OR** 2250 psi (15.5 MPa), **as directed**, for 12-inch nominal- (286-mm actual-) depth members.
    - b. Modulus of Elasticity, Edgewise: 2,000,000 psi (13 700 MPa) **OR** 1,800,000 psi (12 400 MPa) **OR** 1,500,000 psi (10 300 MPa), **as directed**.
  - 2. Parallel-Strand Lumber: Structural composite lumber made from wood strand elements with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559 and containing no urea formaldehyde.
    - a. Extreme Fiber Stress in Bending, Edgewise: 2900 psi (20 MPa) for 12-inch nominal- (286-mm actual-) depth members.
    - b. Modulus of Elasticity, Edgewise: 2,200,000 psi (15 100 MPa).
  - 3. Wood I-Joists: Prefabricated units, I-shaped in cross section, made with solid or structural composite lumber flanges and wood-based structural panel webs, let into and bonded to flanges. Provide units complying with material requirements of and with structural capacities established and monitored according to ASTM D 5055.
    - a. Provide I-joists manufactured without urea formaldehyde.
    - b. Web Material: Either oriented strand board or plywood, complying with DOC PS 1 or DOC PS 2, Exposure 1 **OR** Plywood, complying with DOC PS 1 or DOC PS 2, Exposure 1 **OR** Plywood, complying with DOC PS 1, Exterior grade, **as directed**.
    - c. Structural Properties: Provide units with depths and design values not less than those indicated.
    - d. Provide units complying with APA PRI-400, factory marked with APA trademark indicating nominal joist depth, joist class, span ratings, mill identification, and compliance with APA standard.



4. Rim Boards: Product designed to be used as a load-bearing member and to brace wood I-joists at bearing ends, complying with research/evaluation report for I-joists.
  - a. Manufacturer: Provide products by same manufacturer as I-joists.
  - b. Material: All-veneer product **OR** glued-laminated wood **OR** product made from any combination solid lumber, wood strands, and veneers, **as directed**. Provide rim boards made without urea formaldehyde.
  - c. Thickness: 1 inch (25 mm) **OR** 1-1/8 inches (28 mm) **OR** 1-1/4 inches (32 mm), **as directed**.
  - d. Provide performance-rated product complying with APA PRR-401, rim board **OR** rim board plus, **as directed**, grade, factory marked with APA trademark indicating thickness, grade, and compliance with APA standard.

#### G. Miscellaneous Lumber

1. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
  - a. Blocking.
  - b. Nailers.
  - c. Rooftop equipment bases and support curbs.
  - d. Cants.
  - e. Furring.
  - f. Grounds.
  - g. Utility shelving.
2. For items of dimension lumber size, provide Construction or No. 2 **OR** Standard, Stud, or No. 3, **as directed**, grade lumber with 15 **OR** 19, **as directed**, percent maximum moisture content of any species.
3. For items of dimension lumber size, provide Construction or No. 2 **OR** Standard, Stud, or No. 3, **as directed**, grade lumber with 15 **OR** 19, **as directed**, percent maximum moisture content and any of the following species:
  - a. Hem-fir (north); NLGA.
  - b. Mixed southern pine; SPIB.
  - c. Spruce-pine-fir; NLGA.
  - d. Hem-fir; WCLIB, or WWPA.
  - e. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
  - f. Western woods; WCLIB or WWPA.
  - g. Northern species; NLGA.
  - h. Eastern softwoods; NeLMA.
4. For exposed boards, provide lumber with 15 **OR** 19, **as directed**, percent maximum moisture content and any of the following species and grades:
  - a. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Premium or 2 Common (Sterling) **OR** Standard or No. 3 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
  - b. Mixed southern pine, No. 1 **OR** 2, **as directed**, grade; SPIB.
  - c. Hem-fir or hem-fir (north), Select Merchantable or No. 1 Common **OR** Construction or No. 2 Common, **as directed**, grade; NLGA, WCLIB, or WWPA.
  - d. Spruce-pine-fir (south) or spruce-pine-fir, Select Merchantable or No. 1 Common **OR** Construction or No. 2 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
5. For concealed boards, provide lumber with 15 **OR** 19, **as directed**, percent maximum moisture content and any of the following species and grades:
  - a. Mixed southern pine, No. 2 **OR** 3, **as directed**, grade; SPIB.
  - b. Hem-fir or hem-fir (north), Construction or 2 Common **OR** Standard or 3 Common, **as directed**, grade; NLGA, WCLIB, or WWPA.
  - c. Spruce-pine-fir (south) or spruce-pine-fir, Construction or 2 Common **OR** Standard or 3 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
  - d. Eastern softwoods, No. 2 **OR** 3, **as directed**, Common grade; NeLMA.
  - e. Northern species, No. 2 **OR** 3, **as directed**, Common grade; NLGA.



- f. Western woods, Construction or No. 2 Common **OR** Standard or No. 3 Common, **as directed**, grade; WCLIB or WWPA.
  6. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
  7. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
  8. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.
- H. Plywood Backing Panels
1. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, **as directed**, in thickness indicated or, if not indicated, not less than 1/2-inch (13-mm) nominal thickness.
- I. Fasteners
1. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
    - a. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M **OR** of Type 304 stainless steel, **as directed**.
  2. Nails, Brads, and Staples: ASTM F 1667.
  3. Power-Driven Fasteners: NES NER-272.
  4. Wood Screws: ASME B18.6.1.
  5. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
  6. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
  7. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
    - a. Material:
      - 1) Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.  
**OR**  
Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).
- J. Metal Framing Anchors
1. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated **OR** of basis-of-design products, **as directed**. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
  2. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
    - a. Use for interior locations where stainless steel is not indicated.
  3. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** 316, **as directed**.
    - a. Use for exterior locations and where indicated.
  4. Joist Hangers: U-shaped joist hangers with 2-inch- (50-mm-) long seat and 1-1/4-inch- (32-mm-) wide nailing flanges at least 85 percent of joist depth.
  5. I-Joist Hangers: U-shaped joist hangers with 2-inch- (50-mm-) long seat and 1-1/4-inch- (32-mm-) wide nailing flanges full depth of joist. Nailing flanges provide lateral support at joist top chord.
  6. Top Flange Hangers: U-shaped joist hangers, full depth of joist, formed from metal strap with tabs bent to extend over and be fastened to supporting member.
  7. Bridging: Rigid, V-section, nailless type, 0.050 inch (1.3 mm) thick, length to suit joist size and spacing.



8. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post 1 inch (25 mm) above base and with 2-inch- (50-mm-) minimum side cover, socket 0.062 inch (1.6 mm) thick, and standoff and adjustment plates 0.108 inch (2.8 mm) thick.
9. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.
10. Rafter Tie-Downs: Bent strap tie for fastening rafters or roof trusses to wall studs below, 1-1/2 inches (38 mm) wide by 0.050 inch (1.3 mm) thick. Tie fastens to side of rafter or truss, face of top plates, and side of stud below.
11. Rafter Tie-Downs (Hurricane or Seismic Ties): Bent strap tie for fastening rafters or roof trusses to wall studs below, 2-1/4 inches (57 mm) wide by 0.062 inch (1.6 mm) thick. Tie fits over top of rafter or truss and fastens to both sides of rafter or truss, face of top plates, and side of stud below.
12. Floor-to-Floor Ties: Flat straps, with holes for fasteners, for tying upper floor wall studs to band joists and lower floor studs, 1-1/4 inches (32 mm) wide by 0.050 inch (1.3 mm) thick by 36 inches (914 mm) long.
13. Hold-Downs: Brackets for bolting to wall studs and securing to foundation walls with anchor bolts or to other hold-downs with threaded rods and designed with first of two bolts placed seven bolt diameters from reinforced base.
14. Wall Bracing:
  - a. T-shaped bracing made for letting into studs in saw kerf, 1-1/8 inches (29 mm) wide by 9/16 inch (14 mm) deep by 0.034 inch (0.85 mm) thick with hemmed edges.

**OR**

Wall Bracing: Angle bracing made for letting into studs in saw kerf, 15/16 by 15/16 by 0.040 inch (24 by 24 by 1 mm) thick with hemmed edges.

#### K. Miscellaneous Materials

1. Sill-Sealer Gaskets:
  - a. Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; 1-inch (25-mm) nominal thickness, compressible to 1/32 inch (0.8 mm); selected from manufacturer's standard widths to suit width of sill members indicated.

**OR**

Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to suit width of sill members indicated.
2. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
  - a. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chloropyrifos as its active ingredient.

### 1.3 EXECUTION

#### A. Installation, General

1. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
2. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.
3. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.
4. Metal Framing Anchors: Install metal framing to comply with manufacturer's written instructions.
5. Do not splice structural members between supports, unless otherwise indicated.



6. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
    - a. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.
  7. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
    - a. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
    - b. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches (2438 mm) o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal- (38-mm actual-) thickness.
    - c. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. (9.3 sq. m) and to solidly fill space below partitions.
    - d. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet (6 m) o.c.
  8. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
  9. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
    - a. Use inorganic boron for items that are continuously protected from liquid water.
    - b. Use copper naphthenate for items not continuously protected from liquid water.
  10. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
    - a. NES NER-272 for power-driven fasteners.
    - b. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
    - c. "Nailing Schedule," and Tables in Section 2304, of ICC's International Building Code.
    - d. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
    - e. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
    - f. Table 602.3(1), "Fastener Schedule for Structural Members," and Table 602.3(2), "Alternate Attachments," in ICC's International One- and Two-Family Dwelling Code.
  11. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.
  12. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.
    - a. Comply with approved **OR** indicated, **as directed**, fastener patterns where applicable. Before fastening, mark fastener locations, using a template made of sheet metal, plastic, or cardboard.
    - b. Use finishing nails, unless otherwise indicated. Do not countersink nail heads **OR** Countersink nail heads and fill holes with wood filler, **as directed**.
- B. Wood Ground, Sleeper, Blocking, And Nailer Installation
1. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
  2. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.



3. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

#### C. Wood Furring Installation

1. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
2. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal- (19-by-63-mm actual-) size furring horizontally **OR** vertically **OR** horizontally and vertically, **as directed**, at 24 inches (610 mm) **OR** 600 mm, **as directed**, o.c.
3. Furring to Receive Gypsum Board **OR** Plaster Lath, **as directed**: Install 1-by-2-inch nominal- (19-by-38-mm actual-) size furring vertically at 16 inches (406 mm) **OR** 400 mm, **as directed**, o.c.

#### D. Wall And Partition Framing Installation

1. General: Provide single bottom plate and double top plates using members of 2-inch nominal (38-mm actual) thickness whose widths equal that of studs, except single top plate may be used for non-load-bearing partitions and for load-bearing partitions where framing members bearing on partition are located directly over studs. Fasten plates to supporting construction, unless otherwise indicated.
  - a. For exterior walls, provide 2-by-6-inch nominal- (38-by-140-mm actual-) **OR** 2-by-4-inch nominal- (38-by-89-mm actual-), **as directed**, size wood studs spaced 24 inches (610 mm) **OR** 16 inches (406 mm) **OR** 600 mm **OR** 400 mm, **as directed**, o.c., unless otherwise indicated.
  - b. For interior partitions and walls, provide 2-by-6-inch nominal- (38-by-140-mm actual-) **OR** 2-by-4-inch nominal- (38-by-89-mm actual-) **OR** 2-by-3-inch nominal- (38-by-64-mm actual-), **as directed**, size wood studs spaced 24 inches (610 mm) **OR** 16 inches (406 mm) **OR** 600 mm **OR** 400 mm, **as directed**, o.c., unless otherwise indicated.
  - c. Provide continuous horizontal blocking at midheight of partitions more than 96 inches (2438 mm) high, using members of 2-inch nominal (38-mm actual) thickness and of same width as wall or partitions.
2. Construct corners and intersections with three or more studs, except that two studs may be used for interior non-load-bearing partitions.
3. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Support headers on jamb studs.
  - a. For non-load-bearing partitions, provide double-jamb studs and headers not less than 4-inch nominal (89-mm actual) depth for openings 48 inches (1200 mm) and less in width, 6-inch nominal (140-mm actual) depth for openings 48 to 72 inches (1200 to 1800 mm) in width, 8-inch nominal (184-mm actual) depth for openings 72 to 120 inches (1800 to 3000 mm) in width, and not less than 10-inch nominal (235-mm actual) depth for openings 10 to 12 feet (3 to 3.6 m) in width.
  - b. For load-bearing walls, provide double-jamb studs for openings 60 inches (1500 mm) and less in width, and triple-jamb studs for wider openings. Provide headers of depth indicated or, if not indicated, according to Table R502.5(1) or Table R502.5(2), as applicable, in ICC's International Residential Code for One- and Two-Family Dwellings.
4. Provide diagonal bracing in exterior walls, at both walls of each external corner **OR** walls, at locations indicated, **as directed**, at 45-degree angle, full-story height, unless otherwise indicated. Use 1-by-4-inch nominal- (19-by-89-mm actual-) size boards, let-in flush with faces of studs **OR** metal wall bracing, let into studs in saw kerf, **as directed**.

#### E. Floor Joist Framing Installation

1. General: Install floor joists with crown edge up and support ends of each member with not less than 1-1/2 inches (38 mm) of bearing on wood or metal, or 3 inches (76 mm) on masonry. Attach floor joists as follows:
  - a. Where supported on wood members, by toe nailing or by using metal framing anchors.



- b. Where framed into wood supporting members, by using wood ledgers as indicated or, if not indicated, by using metal joist hangers.
  2. Fire Cuts: At joists built into masonry, bevel cut ends 3 inches (76 mm) and do not embed more than 4 inches (102 mm).
  3. Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds 48 inches (1200 mm).
  4. Do not notch in middle third of joists; limit notches to one-sixth depth of joist, one-third at ends. Do not bore holes larger than 1/3 depth of joist; do not locate closer than 2 inches (50 mm) from top or bottom.
  5. Provide solid blocking of 2-inch nominal (38-mm actual) thickness by depth of joist at ends of joists unless nailed to header or band.
  6. Lap members framing from opposite sides of beams, girders, or partitions not less than 4 inches (102 mm) or securely tie opposing members together. Provide solid blocking of 2-inch nominal (38-mm actual) thickness by depth of joist over supports.
  7. Anchor members paralleling masonry with 1/4-by-1-1/4-inch (6.4-by-32-mm) metal strap anchors spaced not more than 96 inches (2438 mm) o.c., extending over and fastening to 3 joists. Embed anchors at least 4 inches (102 mm) into grouted masonry with ends bent at right angles and extending 4 inches (102 mm) beyond bend.
  8. Provide solid blocking between joists under jamb studs for openings.
  9. Under non-load-bearing partitions, provide double joists separated by solid blocking equal to depth of studs above.
    - a. Provide triple joists separated as above, under partitions receiving ceramic tile and similar heavy finishes or fixtures.
  10. Provide bridging of type indicated below, at intervals of 96 inches (2438 mm) o.c., between joists.
    - a. Diagonal wood bridging formed from bevel-cut, 1-by-3-inch nominal- (19-by-64-mm actual-) size lumber, double-crossed and nailed at both ends to joists.
    - b. Steel bridging installed to comply with bridging manufacturer's written instructions.
- F. Ceiling Joist And Rafter Framing Installation
  1. Ceiling Joists: Install ceiling joists with crown edge up and complying with requirements specified above for floor joists. Face nail to ends of parallel rafters.
    - a. Where ceiling joists are at right angles to rafters, provide additional short joists parallel to rafters from wall plate to first joist; nail to ends of rafters and to top plate and nail to first joist or anchor with framing anchors or metal straps. Provide 1-by-8-inch nominal- (19-by-184-mm actual-) size or 2-by-4-inch nominal- (38-by-89-mm actual-) size stringers spaced 48 inches (1200 mm) o.c. crosswise over main ceiling joists.
  2. Rafters: Notch to fit exterior wall plates and toe nail or use metal framing anchors. Double rafters to form headers and trimmers at openings in roof framing, if any, and support with metal hangers. Where rafters abut at ridge, place directly opposite each other and nail to ridge member or use metal ridge hangers.
    - a. At valleys, provide double-valley rafters of size indicated or, if not indicated, of same thickness as regular rafters and 2 inches (50 mm) deeper. Bevel ends of jack rafters for full bearing against valley rafters.
    - b. At hips, provide hip rafter of size indicated or, if not indicated, of same thickness as regular rafters and 2 inches (50 mm) deeper. Bevel ends of jack rafters for full bearing against hip rafter.
  3. Provide collar beams (ties) as indicated or, if not indicated, provide 1-by-6-inch nominal- (19-by-140-mm actual-) size boards between every third pair of rafters, but not more than 48 inches (1219 mm) o.c. Locate below ridge member, at third point of rafter span. Cut ends to fit roof slope and nail to rafters.
  4. Provide special framing as indicated for eaves, overhangs, dormers, and similar conditions, if any.
- G. Timber Framing Installation



1. Install timber with crown edge up and provide not less than 4 inches (102 mm) of bearing on supports. Provide continuous members, unless otherwise indicated; tie together over supports as indicated if not continuous.
2. Where beams or girders are framed into pockets of exterior concrete or masonry walls, provide 1/2-inch (13-mm) air space at sides and ends of wood members.
3. Install wood posts using metal anchors indicated.
4. Treat ends of timber beams and posts exposed to weather by dipping in water-repellent preservative for 15 minutes.

#### H. Stair Framing Installation

1. Provide stair framing members of size, space, and configuration indicated or, if not indicated, to comply with the following requirements:
  - a. Stringer Size: 2-by-12-inch nominal- (38-by-286-mm actual-) size, minimum.
  - b. Stringer Material: Laminated-veneer lumber **OR** parallel-strand lumber **OR** solid lumber, **as directed**.
  - c. Notching: Notch stringers to receive treads, risers, and supports; leave at least 3-1/2 inches (89 mm) of effective depth.
  - d. Stringer Spacing: At least 3 stringers for each 36-inch (914-mm) clear width of stair.
2. Provide stair framing with no more than 3/16-inch (4.7-mm) variation between adjacent treads and risers and no more than 3/8-inch (9.5-mm) variation between largest and smallest treads and risers within each flight.

#### I. Protection

1. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
2. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 00 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
06 11 13 00	06 10 00 00	Rough Carpentry
06 11 13 00	06 05 23 00a	Miscellaneous Carpentry



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**SECTION 06 11 16 00 - ROUGH CARPENTRY RENOVATION**

## 1.1 DESCRIPTION OF WORK

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

## 1.2 GENERAL

## A. Quality Assurance

## 1. Regulatory Requirements:

- a. Fire Retardant Treated Lumber and Plywood: Bear UL FR-S classification label.
- b. Preservative Treated Wood: Provide all heart redwood, cedar, or cyprus; or preservative-treated wood at following conditions in accordance with applicable building code:
  - 1) Wood framing, woodwork, and plywood up to and including subflooring at first-floor level of structures having crawl spaces, when bottoms of such items are 150 mm (6 inches) or less from earth underneath.
  - 2) Exterior wood steps, platforms, and railings.
  - 3) Wood sills, soles, plates, furring, and sleepers that are less than 150 mm (6 inches) from earth, furring and nailers that are set into or in contact with concrete or masonry.
  - 4) Nailers, edge strips, crickets, curbs, and cants for roof decks.
  - 5) Furring strips used on walls or partitions below grade and exterior walls above grade.
  - 6) Wood members used for rough framing of openings in exterior concrete or masonry walls.

## B. Delivery, Storage, And Handling

1. General: Deliver material to site, off-load, and handle in manner that will not damage material. Store material off ground and cover with waterproof covering. Provide adequate ventilation.
  - a. Interior Fire-Retardant Treated Wood: Keep dry at all times. Replace material that has become wet. Store off ground, in building, or covered with unbroken water-tight cover in storage yard, during transit, and at job site. Keep ventilated to avoid moisture condensation.

## C. Project Conditions

1. Environmental Requirements: Execute demolition and renovation in manner to limit unnecessary dust and noise, and in compliance with applicable codes and federal or state requirements. Burning of materials on site not allowed.
2. Existing Conditions: See Detailed Scope of Work. Do not interfere with use of occupied buildings or portions of buildings. Maintain free and safe passage to and from occupied areas.
3. Protection:
  - a. Provide necessary temporary shoring and bracing to support and protect portions of existing buildings during demolition operations. Leave such shoring in place until permanent supports have been installed. Be solely responsible for design, safety, and adequacy of temporary shoring and bracing and its ability to carry load for which intended.
  - b. Contractor: Protect grounds, plantings, buildings, and any other facilities or property from damage caused by construction operations.
4. Safety: Cease operations at endangered area, and notify the Owner immediately if safety of structure appears to be endangered. Take precautions to properly support structure. Do not resume work in endangered area until safety is restored.

## D. Scheduling And Sequencing



1. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

### 1.3 PRODUCTS

#### A. Materials

1. Materials for Patching, Extending, and Matching:
  - a. Provide same products or types of construction as in existing structure, as needed to patch, extend, or match existing work.
    - 1) Generally, Contract Documents will not define products or standards of workmanship present in existing construction. Determine products by inspection and testing as necessary, and required workmanship by reference to existing as sample of comparison.
    - 2) Patching, extending, and matching existing work and systems shall result in complete, finished system.
  - b. Presence of product, finish, or type of construction requires that patching, extending, or matching be performed as necessary to make work complete and consistent.
2. Lumber: Each Piece of Lumber: Grade stamped by recognized association or independent inspection agency certified by American Lumber Standards Committee's Board of Review.
  - a. New Replacement Studs and Joists: Match existing and complies with Reference Standards.
  - b. Wood Studs and Joists: No. 2 Grade or better.
  - c. Sill Plates on Concrete: All heart redwood, cedar, or cyprus: or preservative-treated wood.
  - d. Blocking and Furring: Standard Grade or Better.
  - e. Preservative-Treated: AWPB LP-2, pressure-treated with waterborne preservative. Penta or creosote not allowed.
    - 1) Treat drilled holes and cuts across grain in accordance with AWPA M4.
  - f. Fire-Retardant Treated:
    - 1) Lumber: AWPA C20 Interior Type A.
    - 2) Plywood: AWPA C27 Interior Type A.
    - 3) Bear UL FR-S classification label.
  - g. Pressure-Treated Lumber: Bear AWPA Quality Mark C-2.
  - h. Seasoning: Kiln dry to following (including treated material):
  - i. Lumber Up to 50 mm (2 inches): 19 percent or less moisture content.
  - j. Preservative- and Fire-Retardant Treated Material: Mill or rip material parallel to grain prior to treatment.
3. Plywood: PS-1: Each panel identified with APA grade trademark.
  - a. Subfloor: APA Rated Sheathing, Tongue and groove, Exposure 1 (interior with exterior glue).
    - 1) Span Rating: Not less than spacing of framing members.
    - 2) Thickness: In accordance with APA Recommendations.
  - b. Roof Sheathing: APA Rated Sheathing, Exposure 1 (interior with exterior glue).
    - 1) Span Rating: Not less than spacing of framing members.
    - 2) Thickness: In accordance with APA Recommendations.
  - c. Wall Sheathing: APA CD, Exposure 1 (Interior with exterior glue).
    - 1) Span Rating: Not less than spacing of framing members.
    - 2) Thickness: As indicated.
  - d. Panel Edge Clips: Extruded aluminum or hot-dipped galvanized steel, H-shaped clips to prevent differential deflection of roof sheathing.
  - e. Fire-Retardant Treated Plywood: Bear UL FR-S classification label.
    - 1) Interior Plywood Fire Retardant Treatment: AWPA C27 Interior Type A.
    - 2) Exterior Plywood Fire Retardant Treatment: AWPA C27 Exterior Type.
  - f. Seasoning: Kiln dry plywood to 15 percent or less moisture content.
    - 1) Pressure Treated Plywood: Kiln dry lumber after treatment.
  - g. Nails: Type and size as recommended by APA.



4. Metal Framing Anchors: Punched and formed for nailing so that nails will be stressed in shear only.
  - a. General: Provide with nails and bolts according to manufacturers requirements.
    - 1) Nails: Zinc coated.
  - b. Types: As indicated and as required to accommodate framing.
  - c. Sizes: Of sufficient size and strength to develop full strength of supported member in accordance with applicable building code.
  - d. Metal Bridging: Minimum No. 16 U.S. Standard gage.
  - e. Finish: Hot-dipped galvanized.
5. Anchor Bolts: Furnish anchors to be built into concrete and masonry for anchorage of wood.
6. Rough Hardware: Provide necessary bolts, screws, nails, clips, plates, straps, hangers, etc., necessary for completion of renovation work. Provide correct material of proper size and strength for purpose intended, conforming to Reference Standards and applicable building codes.
  - a. Exterior Locations and for Fire-Retardant- and Preservative-Treated Wood: Provide galvanized rough hardware.
7. Vapor Barrier at Crawl Spaces: ASTM D 2103, 0.15 mm (6 mil) polyethylene sheeting.
8. Insulation: Type and R-value to comply with applicable codes and regulations.
  - a. Blanket Insulation: ASTM C 665 fiberglass blankets. Exposed insulation shall be foil-faced with flame-spread rating of 25 or less in accordance with ASTM E 84, where required by applicable codes and regulations.

#### 1.4 EXECUTION

##### A. Examination

1. Units, Spaces, and Areas to be Renovated: Comply with Detailed Scope of Work.
  - a. Verify that surfaces to receive rough carpentry are prepared to require grades and dimensions.

##### B. Preparation

1. Dust Protection: Comply with Detailed Scope of Work.
2. Building Occupation: Carry out demolition and renovation work to cause as little inconvenience to occupants as possible. See Detailed Scope of Work.
3. Protection: See Detailed Scope of Work.
4. Selective Demolition: Comply with Detailed Scope of Work.

##### C. Laying Out Work

1. Discrepancies: Verify dimensions and elevations indicated in layout of existing work.
  - a. Prior to commencing work, carefully compare and check Drawings (if any) for discrepancies in locations or elevations of work to be executed.
  - b. Refer discrepancies among Drawings (if any), Specifications, and existing conditions to the Owner for adjustment before work affected is performed.
    - 1) Failure to make such notification shall place responsibility on Contractor to carry out work in satisfactory, workmanlike manner.
2. Contractor: Responsible for location and elevation of construction contemplated by Construction Documents.

##### D. Performance

1. Patching: Patch and extend existing work using skilled mechanics who are capable of matching existing quality of workmanship.
  - a. Quality of Patched or Extended Work: Not less than specified for new work. If similar new work is not specified, equal to existing work.
2. General: Perform in accordance with AF&PA National Design Specification for Wood Construction, latest Edition.
  - a. Framing: Erect plumb, level and true and rigidly anchor in place. Cut framing square on bearings, closely fit, accurately set to required lines and levels.



- b. Nail or spike members in accordance with applicable codes.
  - c. Framing: 400 mm (16 inches) OC unless otherwise indicated.
  - d. Shims: Do not use shims for leveling on wood or metal bearings. Use steel or slate shims with full bearing on masonry or concrete.
  - e. Do not splice framing members between bearing points.
  - f. Metal Framing Anchors: Install where required for proper connections in accordance with manufacturer recommendations. Drive nail in each nail hole provided in anchor.
3. Wood Framing:
- a. Openings: Frame members for passage of pipes and ducts to avoid cutting structural members. Do not cut, notch, or bore framing members for passage of pipes or conduits without the Owner's permission. Reinforce framing members as directed where damaged by cuffing.
  - b. Firestopping: Firestop concealed spaces in framing. No shutoff by framing members to prevent drafts from one space to another. Use 50 mm (2 inch) nominal thick accurately fit wood blocking to fill opening.
  - c. Joists and Beams: Sizes and spacing as indicated.
    - 1) Set crown edge-up with 90 mm (3-1/2 inch) bearing unless noted otherwise.
    - 2) Toe nail joists to wood sills with 16d nails both sides or secure with metal connectors. Lap and spike joists over supports.
    - 3) Double joists to form headers and trimmers at openings over 1,200 mm (4 feet) and support with metal joist hangers.
    - 4) Provide joist hangers at joists framing into flush wood beams.
  - d. Provide blocking or suitable edge support between members as necessary to support edges of sheathing.
  - e. Replace warped lumber in walls and joists prior to installation of finish surface.
4. Anchors: Unless otherwise indicated, bolt plates firmly to concrete or masonry with anchor bolts in accordance with applicable code.
- a. In Masonry: Embed anchor bolts minimum 400 mm (16 inches) and provide each with nut and 50 mm (2 inch) diameter washer at bottom end. Grout bolts with mortar.
  - b. In Concrete: Embed anchor bolts minimum 200 mm (8 inches) and provide each with nut and 50 mm (2 inch) diameter washer at bottom end. 90 degree bent end may be substituted for nut and washer.
5. Wood Studs: Install at 400 mm (16 inches) OC with single bottom plate and double top plate with joints staggered.
- a. Double studs at openings and triple at corners and intersections. Double headers with double trimmers over openings.
6. Plywood Sheathing: Install in accordance with APA Recommendations.
- a. Provide space at end and side joints as recommended by APA.
  - b. Install panels with face grain perpendicular to supports with end-joints supported. Stagger ends of adjacent sheets 1 200 mm (4 feet) where possible.
  - c. Where support spacing exceeds maximum span for unsupported edge, provide adequate blocking, tongue and groove edges, or panel edge clips, in accordance with APA E30-L.
  - d. Nail in accordance with APA's Recommendations.
7. Preservative- and Fire-Retardant Material: Milling or ripping material parallel to grain not allowed unless material is treated after milling or ripping.
- a. Preservative-Treated Material: Treat drilled holes and cuts across grain in accordance with AWPA M4.

#### E. Flooring Work

- 1. Defective Joists and Subfloor: Remove defective joists and subfloor which no longer satisfy structural requirements with 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



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
06 11 16 00	01 22 16 00	No Specification Required
06 11 16 00	06 10 00 00	Rough Carpentry
06 11 16 00	06 05 23 00a	Miscellaneous Carpentry



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**SECTION 06 15 13 00 - EXTERIOR ROUGH CARPENTRY**

## 1.1 GENERAL

## A. Description Of Work:

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

## B. Summary

1. Section Includes:
  - a. Elevated decks including wood decking, plastic decking, stairs, railings, and support framing.
  - b. Wood benches.

## C. Definitions

1. Boards: Lumber of less than 2 inches nominal (38 mm actual) in thickness and 2 inches nominal (38 mm actual) or greater width.
2. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.
3. Timber: Lumber of 5 inches nominal (114 mm actual) or greater in least dimension.
4. Lumber grading agencies, and the abbreviations used to reference them, include the following:
  - a. NeLMA: Northeastern Lumber Manufacturers' Association.
  - b. NLGA: National Lumber Grades Authority.
  - c. RIS: Redwood Inspection Service.
  - d. SPIB: The Southern Pine Inspection Bureau.
  - e. WCLIB: West Coast Lumber Inspection Bureau.
  - f. WWPA: Western Wood Products Association.

## D. Submittals

1. Product Data: For preservative-treated wood products, plastic decking, and metal framing anchors.
2. LEED Submittal:
  - a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood products comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
3. Material Certificates:
  - a. For lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by ALSC's Board of Review.
  - b. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.
4. Evaluation Reports: For the following, from an approved organization/model code, as directed by the Owner:
  - a. Preservative-treated wood products.
  - b. Plastic decking.
  - c. Expansion anchors.
  - d. Metal framing anchors.
  - e. Decking fasteners.

## E. Quality Assurance

1. Forest Certification: Provide wood products obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."



F. Delivery, Storage, And Handling

1. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
2. Handle and store plastic lumber to comply with manufacturer's written instructions.

1.2 PRODUCTS

A. Lumber, General

1. Lumber: Comply with DOC PS 20 and with applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by ALSC's Board of Review. Provide lumber graded by an agency certified by ALSC's Board of Review to inspect and grade lumber under the rules indicated.
  - a. Factory mark each item with grade stamp of grading agency.
  - b. For items that are exposed to view in the completed Work, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
  - c. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
  - d. Provide dressed lumber, S4S, unless otherwise indicated.

B. Dimension Lumber

1. Maximum Moisture Content: 15 percent **OR** 19 percent **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less; 19 percent for more than 2-inch nominal (38-mm actual) thickness **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness **OR** 19 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness, **as directed**.
2. Deck and Stair Framing: Select Structural **OR** No. 1 **OR** No. 2 **OR** Construction or No. 2 **OR** Construction, Stud, or No. 3, **as directed**, grade and as selected from the following species:
  - a. Hem-fir (North); NLGA.
  - b. Southern pine; SPIB.
  - c. Douglas fir-larch; WCLIB or WWPA.
  - d. Mixed southern pine; SPIB.
  - e. Spruce-pine-fir; NLGA.
  - f. Douglas fir-south; WWPA.
  - g. Hem-fir; WCLIB or WWPA.
  - h. Douglas fir-larch (North); NLGA.
  - i. Spruce-pine-fir (South); NeLMA, WCLIB, or WWPA.

**OR**

Deck and Stair Framing: Any species and grade with a modulus of elasticity of at least 1,500,000 psi (10 350 MPa) **OR** 1,300,000 psi (8970 MPa) **OR** 1,100,000 psi (7590 MPa) **OR** 1,000,000 psi (6900 MPa) **OR** 900,000 psi (6210 MPa), **as directed**, and an extreme fiber stress in bending of at least 1000 psi (6.9 MPa) **OR** 850 psi (5.86 MPa) **OR** 700 psi (4.83 MPa) **OR** 600 psi (4.14 MPa) **OR** 500 psi (3.45 MPa), **as directed**, for 2-inch nominal (38-mm actual) thickness and 12-inch nominal (286-mm actual) width for single-member use.

3. Dimension Lumber Posts: No. 2 **OR** Construction or No. 2 **OR** Construction, Stud, or No. 3, **as directed**, grade and as selected from the following species:
  - a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
  - b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
  - c. Mixed southern pine; SPIB.
  - d. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.
  - e. Northern species; NLGA.
  - f. Eastern softwoods; NeLMA.



- g. Western woods; WCLIB or WWPA.
4. Dimension Lumber Decking and Stair Treads: No. 2 **OR** Construction or No. 2, **as directed**, grade and as selected from the following species:
- a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
  - b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
  - c. Mixed southern pine; SPIB.
  - d. Redwood; RIS.
- OR**
- Dimension Lumber Decking and Stair Treads: Deck Heart or Construction Heart **OR** Deck Common or Construction Common, **as directed**, redwood; RIS.
5. Dimension Lumber Railing Members: Select Structural **OR** No. 1 **OR** No. 2 **OR** Construction or No. 2, **as directed**, grade and as selected from the following species:
- a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
  - b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
  - c. Mixed southern pine; SPIB.
  - d. Redwood; RIS.
  - e. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.
- OR**
- Dimension Lumber Railing Members: Heart Clear **OR** Heart B or Select Heart, **as directed**, redwood; RIS.
6. Dimension Lumber for Benches: Select Structural **OR** No. 1, **as directed**, grade and as selected from the following species:
- a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
  - b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
  - c. Mixed southern pine; SPIB.
  - d. Redwood; RIS.
  - e. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.
- OR**
- Dimension Lumber for Benches: Heart Clear **OR** Heart B or Select Heart, **as directed**, redwood; RIS.
- C. Boards
1. Maximum Moisture Content: 15 **OR** 19, **as directed**, percent.
2. Board Decking and Stair Treads: 1-1/4-inch- (32-mm-) thick radius-edged decking of any of the following species and grades:
- a. Douglas fir-larch or Douglas fir-south, Patio 1 **OR** Patio 2, **as directed**, WWPA.
  - b. Douglas fir-larch, Select Dex **OR** Commercial Dex, **as directed**, WCLIB.
  - c. Douglas fir-larch (North), Select Patio **OR** Commercial Patio, **as directed**, NLGA.
  - d. Hem-fir, Patio 1 **OR** Patio 2, **as directed**, WWPA.
  - e. Hem-fir, Select Dex **OR** Commercial Dex, **as directed**, WCLIB.
  - f. Hem-fir (North), Select Patio **OR** Commercial Patio, **as directed**, NLGA.
  - g. Redwood, Heart Clear **OR** Heart B or Select Heart, **as directed**; RIS.
  - h. Southern pine, Premium **OR** Standard, **as directed**, SPIB.
  - i. Western red cedar, Patio 1 **OR** Patio 2, **as directed**, WWPA.
  - j. Western red cedar, Select Dex **OR** Commercial Dex, **as directed**, WCLIB.
  - k. Western red cedar (North), Select Patio **OR** Commercial Patio, **as directed**, NLGA.
3. Railing Boards: Any of the following species and grades:
- a. Douglas fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
  - b. Hem-fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
  - c. Redwood, Heart Clear **OR** Heart B or Select Heart, **as directed**; RIS.
  - d. Southern pine, B & B finish; SPIB.
4. Boards for Benches: Any of the following species and grades:
- a. Douglas fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
  - b. Hem-fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
  - c. Redwood, Heart Clear **OR** Heart B or Select Heart, **as directed**; RIS.



- d. Southern pine, Edge Grain B & B finish **OR** Near Rift B & B finish **OR** B & B finish, **as directed**; SPIB.

D. Timber

1. Maximum Moisture Content: 19 percent **OR** No limit, **as directed**.
2. Dressing: Provide dressed timber (S4S) or timber that is rough sawn (Rgh) unless otherwise indicated.
3. Timber Posts:
  - a. Balsam fir, Douglas fir-larch, Douglas fir-larch (North), eastern hemlock tamarack (North), hem-fir, southern pine, western hemlock, or western hemlock (North); No. 1 **OR** No. 2, **as directed**, NeLMA, NLGA, SPIB, WCLIB, or WWPA.
  - b. Alaska cedar; No. 1 **OR** No. 2, **as directed**, WCLIB.
  - c. Southern pine; No. 1 **OR** No. 2, **as directed**, SPIB.

E. Round Wood Poles

1. Round Wood Poles: Clean-peeled wood poles complying with ASTM D 3200; with at least 80 percent of inner bark removed and with knots and limbs cut flush with the surface.
2. Species: as directed by the Owner.

F. Preservative Treatment

1. Pressure treat boards and dimension lumber with waterborne preservative according to AWPA C2.
2. Pressure treat timber with waterborne preservative according to AWPA C15 requirements for "sawn building poles and posts as structural members."
  - a. Treatment with CCA shall include post-treatment fixation process.
3. Pressure treat poles with waterborne preservative to comply with AWPA C4.
  - a. Treatment with CCA shall include post-treatment fixation process.
4. Preservative Chemicals: Acceptable to authorities having jurisdiction.
  - a. Do not use chemicals containing arsenic or chromium except for timber posts **OR** except for poles, **as directed**.
5. Use process that includes water-repellent treatment.  
**OR**  
Use process that does not include water repellents or other substances that might interfere with application of indicated finishes.
6. After treatment, redry boards, dimension lumber, timber, and poles to 19 percent maximum moisture content.
7. Mark treated wood with treatment quality mark of an inspection agency approved by ALSC's Board of Review.
  - a. For items indicated to receive a stained or natural finish, mark each piece on surface that will not be exposed or omit marking and provide certificates of treatment compliance issued by inspection agency.
8. Application: Treat all exterior rough carpentry unless otherwise indicated **OR** Treat items indicated on Drawings and the following, **as directed**:
  - a. Framing members less than 18 inches (460 mm) above grade.
  - b. Sills and ledgers.
  - c. Members in contact with masonry or concrete.
  - d. Posts.
  - e. Round wood poles.
  - f. Decking.
  - g. Stair treads.

G. Plastic Decking

1. Plastic Lumber, General: Products acceptable to authorities having jurisdiction and for which current model code evaluation reports exist that show compliance with building code in effect for Project for indicated occupancy and type of construction.



- a. Allowable loads and spans, as documented in evaluation reports or in information referenced in evaluation reports, shall not be less than design loads and spans indicated.
  2. Composite Plastic Lumber: Solid or hollow shapes made from a mixture of cellulose fiber and polyethylene or polypropylene.
    - a. Configuration: Provide product with grooved edges designed for fastening with concealed splines.
    - b. Surface Texture: Woodgrain **OR** Smooth **OR** Manufacturer's standard, **as directed**.
    - c. Color: As selected from manufacturer's full range.
  3. All-Plastic Lumber: Solid or hollow shapes made from high-density polyethylene (HDPE) **OR** PVC **OR** polystyrene **OR** cellular PVC, **as directed**, with no cellulose fiber.
    - a. Configuration: Provide product with grooved edges designed for fastening with concealed splines **OR** tongue-and-groove edges designed for concealed fastening, **as directed**.
    - b. Surface Texture: Woodgrain **OR** Smooth **OR** Manufacturer's standard, **as directed**.
    - c. Color: As selected from manufacturer's full range.
- H. Fasteners
1. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches (38 mm) into wood substrate.
    - a. Use stainless steel **OR** fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M or ASTM F 2329, **as directed**, unless otherwise indicated.
    - b. For pressure-preservative-treated wood, use stainless-steel fasteners.
    - c. For plastic **OR** wood, **as directed**, decking, use stainless-steel fasteners where fasteners are exposed to view.
    - d. For redwood, use brass/bronze **OR** stainless-steel **OR** hot-dip galvanized-steel, **as directed**, fasteners.
  2. Nails: ASTM F 1667.
  3. Power-Driven Fasteners: NES NER-272.
  4. Wood Screws: ASME B18.6.1.
  5. Lag Screws: ASME B18.2.1 (ASME B18.2.3.8M).
  6. Carbon-Steel Bolts: ASTM A 307 (ASTM F 568M) with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers all hot-dip zinc coated.
  7. Stainless-Steel Bolts: ASTM F 593, Alloy Group 1 or 2 (ASTM F 738M, Grade A1 or A4); with ASTM F 594, Alloy Group 1 or 2 (ASTM F 836M, Grade A1 or A4) hex nuts and, where indicated, flat washers.
  8. Postinstalled Anchors: Stainless-steel, chemical or torque-controlled expansion anchors with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
    - a. Stainless-steel bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).
- I. Metal Framing Anchors
1. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated on Drawings **OR** of basis-of-design products, **as directed**. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
  2. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) **OR** G90 (Z270) **OR** G185 (Z550), **as directed**, coating designation.
  3. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** Type 316, **as directed**.
  4. Joist Hangers: U-shaped, with 2-inch- (50-mm-) long seat and 1-1/4-inch- (32-mm-) wide nailing flanges at least 85 percent of joist depth.
  5. Top Flange Hangers: U-shaped joist hangers, full depth of joist, formed from metal strap with tabs bent to extend over and be fastened to supporting member.



6. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post 1 inch (25 mm) above base and with 2-inch- (50-mm-) minimum side cover, socket 0.062 inch (1.6 mm) thick, and standoff and adjustment plates 0.108 inch (2.8 mm) thick.
7. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.

J. Concealed Decking Fasteners

1. Deck Splines: Plastic splines designed to fit in grooves routed into the sides of decking material and be fastened to deck framing with screws. Splines provide uniform spacing of decking material. Splines are made from UV-resistant polypropylene.
2. Deck Clips: Black oxide coated stainless-steel clips designed to be fastened to deck framing with screws, and to secure decking material with teeth that also provide uniform spacing of decking material.
3. Deck Tracks: Formed metal strips designed to be fastened to deck framing and to secure decking material from underside with screws. Made from epoxy powder-coated, hot-dip galvanized steel **OR** stainless steel, **as directed**.

### 1.3 EXECUTION

A. Preparation

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

B. Installation, General

1. Set exterior rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit exterior rough carpentry to other construction; scribe and cope as needed for accurate fit.
2. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction" unless otherwise indicated.
3. Install wood decking and stair treads with crown up (bark side down).
4. Install plastic lumber to comply with manufacturer's written instructions.
5. Secure decking to framing with concealed decking fasteners.
6. Install metal framing anchors to comply with manufacturer's written instructions.
7. Do not splice structural members between supports unless otherwise indicated.
8. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
9. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
10. Comply with AWWA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
  - a. Use inorganic boron (SBX) for items that are continuously protected from liquid water.
  - b. Use copper naphthenate for items not continuously protected from liquid water.
11. Securely attach exterior rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
  - a. NES NER-272 for power-driven fasteners.
  - b. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
  - c. "Nailing Schedule," and Tables in Section 2304 of the ICC's International Building Code.
  - d. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
  - e. Table R602.3(1), "Fastener Schedule for Structural Members" and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
12. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view. Make tight connections



between members. Install fasteners without splitting wood; do not countersink nail heads unless otherwise indicated.

13. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.

C. Elevated Deck Joist Framing Installation

1. General: Install joists with crown edge up and support ends of each member with not less than 1-1/2 inches (38 mm) of bearing on wood or metal, or 3 inches (76 mm) on masonry. Attach floor joists where framed into wood supporting members by using wood ledgers as indicated or, if not indicated, by using metal joist hangers. Do not notch joists.
2. Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds 48 inches (1200 mm).
3. Lap members framing from opposite sides of beams or girders not less than 4 inches (102 mm) or securely tie opposing members together. Provide solid blocking of 2-inch nominal (38-mm actual) thickness by depth of joist over supports.
4. Provide solid blocking of 2-inch nominal (38-mm actual) thickness by depth of joist at intervals of 96 inches (2438 mm) o.c., between joists.

D. Stair Installation

1. Provide stair framing members of size, space, and configuration indicated or, if not indicated, to comply with the following requirements:
  - a. Stringer Size: 2 by 12 inches nominal (38 by 286 mm actual), minimum.
  - b. Notching: Notch stringers to receive treads, risers, and supports; leave at least 3-1/2 inches (89 mm) of effective depth.
  - c. Stringer Spacing: At least three stringers for each 36-inch (914-mm) clear width of stair.
2. Provide stair framing with no more than 3/16-inch (4.7-mm) variation between adjacent treads and risers and no more than 3/8-inch (9.5-mm) variation between largest and smallest treads and risers within each flight.
3. Treads and Risers: Secure by gluing and nailing **OR** screwing, **as directed**, to carriages. Countersink fastener heads, fill flush, and sand filler. Extend treads over carriages and finish with bullnose edge.

E. Railing Installation

1. Balusters: Fit to railings, glue, and nail **OR** screw, **as directed**, in place. Countersink fastener heads, fill flush, and sand filler.
2. Newel Posts: Secure to stringers and risers with through bolts **OR** lag screws **OR** countersunk-head wood screws and glue, **as directed**.
3. Railings: Secure wall rails with metal brackets. Fasten freestanding railings to newel posts and to trim at walls with countersunk-head wood screws or rail bolts and glue.

END OF SECTION 06 15 13 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
06 15 13 00	06 10 00 00	Rough Carpentry
06 15 13 00	06 05 23 00a	Miscellaneous Carpentry
06 15 13 00	06 05 73 33	Wood Decking
06 15 13 00	06 11 16 00	Rough Carpentry Renovation



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**SECTION 06 16 23 00 - SHEATHING**

## 1.1 GENERAL

## A. Description Of Work

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

## B. Summary

1. This Section includes the following:
  - a. Wall sheathing.
  - b. Roof sheathing.
  - c. Composite nail base insulated roof sheathing.
  - d. Subflooring.
  - e. Underlayment.
  - f. Building paper.
  - g. Building wrap.
  - h. Sheathing joint-and-penetration treatment.
  - i. Flexible flashing at openings in sheathing.

## C. Submittals

1. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
  - a. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
  - b. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
  - c. For fire-retardant treatments specified to be High-Temperature (HT) type, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5516.
  - d. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
  - e. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
  - f. For building wrap, include data on air-/moisture-infiltration protection based on testing according to referenced standards.
2. LEED Submittals:
  - a. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
  - b. Product Data for Credit EQ 4.4: For composite-wood products, documentation indicating that product contains no urea formaldehyde.
  - c. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
    - 1) Include statement indicating costs for each certified wood product.
3. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
  - a. Preservative-treated plywood.
  - b. Fire-retardant-treated plywood.



- c. Foam-plastic sheathing.
- d. Building wrap.

D. Quality Assurance

1. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
2. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
  - a. Plywood.
  - b. Oriented strand board.
  - c. Fiberboard wall sheathing.
  - d. Particleboard underlayment.
  - e. Hardboard underlayment.

E. Delivery, Storage, And Handling

1. Stack plywood and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

## 1.2 PRODUCTS

A. Wood Panel Products, General

1. Plywood: DOC PS 1 **OR** Either DOC PS 1 or DOC PS 2, unless otherwise indicated, **as directed**.
2. Oriented Strand Board: DOC PS 2.
3. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
4. Factory mark panels to indicate compliance with applicable standard.

B. Preservative-Treated Plywood

1. Preservative Treatment by Pressure Process: 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



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
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 07 62 00 00 - SHEET METAL FLASHING AND TRIM**

## 1.1 GENERAL

## A. Description Of Work:

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

## B. Summary

1. Section Includes:
  - a. Manufactured Products:
    - 1) Manufactured through-wall flashing and counterflashing.
    - 2) Manufactured reglets and counterflashing.
  - b. Formed Products:
    - 1) Formed roof drainage sheet metal fabrications.
    - 2) Formed low-slope roof sheet metal fabrications.
    - 3) Formed steep-slope roof sheet metal fabrications.
    - 4) Formed wall sheet metal fabrications.
    - 5) Formed equipment support flashing.
    - 6) Formed overhead-piping safety pans.

## C. Performance Requirements

1. General: Sheet metal flashing and trim assemblies as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
2. Fabricate and install roof edge flashing and copings capable of resisting the following forces according to recommendations in FMG Loss Prevention Data Sheet 1-49:
  - a. Wind Zone 1: For velocity pressures of 10 to 20 lbf/sq. ft. (0.48 to 0.96 kPa): 40-lbf/sq. ft. (1.92-kPa) perimeter uplift force, 60-lbf/sq. ft. (2.87-kPa) corner uplift force, and 20-lbf/sq. ft. (0.96-kPa) outward force.
  - b. Wind Zone 1: For velocity pressures of 21 to 30 lbf/sq. ft. (1.00 to 1.44 kPa): 60-lbf/sq. ft. (2.87-kPa) perimeter uplift force, 90-lbf/sq. ft. (4.31-kPa) corner uplift force, and 30-lbf/sq. ft. (1.44-kPa) outward force.
  - c. Wind Zone 2: For velocity pressures of 31 to 45 lbf/sq. ft. (1.48 to 2.15 kPa): 90-lbf/sq. ft. (4.31-kPa) perimeter uplift force, 120-lbf/sq. ft. (5.74-kPa) corner uplift force, and 45-lbf/sq. ft. (2.15-kPa) outward force.
  - d. Wind Zone 3: For velocity pressures of 46 to 104 lbf/sq. ft. (2.20 to 4.98 kPa): 208-lbf/sq. ft. (9.96-kPa) perimeter uplift force, 312-lbf/sq. ft. (14.94-kPa) corner uplift force, and 104-lbf/sq. ft. (4.98-kPa) outward force.
3. Thermal Movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient and surface temperature changes.
  - a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

## D. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: Show installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.



- a. Include details for forming, joining, supporting, and securing sheet metal flashing and trim, including pattern of seams, termination points, fixed points, expansion joints, expansion-joint covers, edge conditions, special conditions, and connections to adjoining work.
3. Samples: For each exposed product and for each finish specified.
4. Maintenance data.
5. Warranty: Sample of special warranty.

E. Quality Assurance

1. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.
2. Copper Sheet Metal Standard: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
3. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
  - a. Build mockup of typical roof eave, including built-in gutter, fascia, fascia trim, and apron flashing, approximately 10 feet (3.0 m) long, including supporting construction cleats, seams, attachments, underlayment, and accessories.
4. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling

1. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
2. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

G. Warranty

1. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within 20 **OR** 10, **as directed**, years from date of Final Completion.

## 1.2 PRODUCTS

A. Sheet Metals

1. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
2. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 or H01 temper.
  - a. Non-Patinated Exposed Finish: Mill.
  - b. Non-Patinated, Exposed, Lacquered Finish: Finish designations for copper alloys comply with the system defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
    - 1) Brushed Satin (Lacquered): M32-06x (Mechanical Finish: directionally textured, medium satin; with clear organic coating); coating of "Incralac," waterborne **OR** solvent-borne, **as directed**, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to a total thickness of 1 mil (0.025 mm).
    - 2) Mirror Polished (Lacquered): M22-06x (Mechanical Finish: buffed, specular; with clear organic coating); coating of "Incralac," waterborne **OR** solvent-borne, **as directed**, air-drying, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to a total thickness of 1 mil (0.025 mm).
  - c. Pre-Patinated Copper-Sheet Finish: Dark brown **OR** Verdigris, **as directed**, pre-patinated according to ASTM B 882.



3. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.
  - a. As-Milled Finish: Mill **OR** One-side bright mill **OR** Standard one-side bright **OR** Standard two-side bright, **as directed**, finish.
  - b. Alclad Finish: Metallurgically bonded surfacing to both sides, forming a composite aluminum sheet with reflective luster.
  - c. Surface: Smooth, flat **OR** Embossed, **as directed**.
  - d. Factory Prime Coating: Where painting after installation is indicated, pretreat with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of 0.2 mil (0.005 mm).
  - e. Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
  - f. Color Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
    - 1) Color: Champagne **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black, **as directed**.
    - 2) Color Range: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
  - g. Exposed Coil-Coated Finishes:
    - 1) Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.
    - 2) Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
    - 3) Four-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats.
    - 4) Mica Fluoropolymer: AAMA 620. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat.
    - 5) Metallic Fluoropolymer: AAMA 620. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
    - 6) FEVE Fluoropolymer: AAMA 620. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat.
    - 7) Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
    - 8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mils (0.97 mm) for topcoat.
  - h. Color: As selected from manufacturer's full range.
  - i. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).
4. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed.
  - a. Finish: 2D (dull, cold rolled) **OR** 2B (bright, cold rolled) **OR** 3 (coarse, polished directional satin) **OR** 4 (polished directional satin), **as directed**.
  - b. Surface: Smooth, flat **OR** Embossed, **as directed**.
5. Zinc-Tin Alloy-Coated Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, dead-soft, fully annealed stainless-steel sheet of minimum uncoated thickness indicated; coated on both sides with a zinc-tin alloy (50 percent zinc, 50 percent tin), with factory-applied gray preweathering.
6. Zinc-Tin Alloy-Coated Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper, of minimum uncoated weight (thickness) indicated; coated on both sides with a zinc-tin alloy (50 percent zinc, 50 percent tin).
7. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.



- a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
  - b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
  - c. Surface: Smooth, flat **OR** Embossed, **as directed**, and mill phosphatized for field painting **OR** and with manufacturer's standard clear acrylic coating on both sides, **as directed**.
  - d. Exposed Coil-Coated Finish:
    - 1) Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.
    - 2) Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
    - 3) Four-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats.
    - 4) Mica Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat.
    - 5) Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
    - 6) FEVE Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat.
    - 7) Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
    - 8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mils (0.97 mm) for topcoat.
  - e. Color: As selected from manufacturer's full range.
  - f. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).
8. Zinc Sheet: Zinc, 99 percent pure, alloyed with a maximum of 1 percent copper and titanium; with manufacturer's standard factory-applied, flexible, protective back coating.
- a. Finish: Bright rolled **OR** Preweathered gray **OR** Preweathered black, **as directed**.
- B. Underlayment Materials
1. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D 4397.
  2. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
  3. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
    - a. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C).
    - b. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C).
  4. Slip Sheet: Building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum, rosin sized.
- C. Miscellaneous Materials
1. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
  2. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
    - a. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.



- 1) Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
  - 2) Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
  - 3) Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
  - b. Fasteners for Copper **OR** Zinc-Tin Alloy-Coated Copper, **as directed**, Sheet: Copper, hardware bronze or Series 300 stainless steel.
  - c. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
  - d. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
  - e. Fasteners for Zinc-Tin Alloy-Coated Stainless-Steel Sheet: Series 300 stainless steel.
  - f. Fasteners for Zinc-Coated (Galvanized) **OR** Aluminum-Zinc Alloy-Coated, **as directed**, Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.
  - g. Fasteners for Zinc Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.
  3. Solder:
    - a. For Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
    - b. For Stainless Steel: ASTM B 32, Grade Sn60, with an acid flux of type recommended by stainless-steel sheet manufacturer.
    - c. For Zinc-Tin Alloy-Coated Stainless Steel **OR** Copper, **as directed**: ASTM B 32, 100 percent tin.
    - d. For Zinc-Coated (Galvanized) Steel: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.
    - e. For Zinc: ASTM B 32, 40 percent tin and 60 percent lead with low antimony, as recommended by manufacturer.
  4. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
  5. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane **OR** polysulfide **OR** silicone, **as directed**, polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
  6. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
  7. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
  8. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
  9. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.
- D. Manufactured Sheet Metal Flashing And Trim
1. Through-Wall Ribbed Sheet Metal Flashing: Manufacture through-wall sheet metal flashing for embedment in masonry with ribs at 3-inch (75-mm) intervals along length of flashing to provide an integral mortar bond. Manufacture through-wall flashing with snaplock receiver on exterior face to receive counterflashing **OR** interlocking counterflashing on exterior face, of same metal as reglet, **as directed**.
    - a. Copper: 10 oz. (0.34 mm thick) minimum for fully concealed flashing; 16 oz. (0.55 mm thick) elsewhere.
    - b. Stainless Steel: 0.016 inch (0.40 mm) thick.
  2. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions **OR** with interlocking counterflashing on exterior face, of same metal as reglet, **as directed**.
    - a. Material: Stainless steel, 0.019 inch (0.48 mm) thick **OR** Copper, 16 oz./sq. ft. (0.55 mm thick) **OR** Aluminum, 0.024 inch (0.61 mm) thick **OR** Galvanized steel, 0.022 inch (0.56 mm) thick, **as directed**.



- b. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
- c. Stucco Type: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
- d. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
- e. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
- f. Accessories:
  - 1) Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
  - 2) Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
- g. Finish: Mill **OR** With manufacturer's standard color coating, **as directed**.

#### E. Fabrication, General

1. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
  - a. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
  - b. Obtain field measurements for accurate fit before shop fabrication.
  - c. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
  - d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.
2. Fabrication Tolerances:
  - a. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.  
**OR**  
Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."
3. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.
4. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
6. Fabricate cleats and attachment devices of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" and by FMG Loss Prevention Data Sheet 1-49, **as directed**, for application, but not less than thickness of metal being secured.
7. Seams:
  - a. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.  
**OR**  
Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
8. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.



9. Do not use graphite pencils to mark metal surfaces.

F. Roof Drainage Sheet Metal Fabrications

1. Hanging Gutters: Fabricate to cross section indicated, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- (2400-mm-) long sections. Furnish flat-stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters.
  - a. Gutter Style: SMACNA designation A **OR** B **OR** C **OR** D **OR** E **OR** F **OR** G **OR** H **OR** I **OR** J **OR** K **OR** L, **as directed**.
  - b. Expansion Joints: Lap type **OR** Butt type **OR** Butt type with cover plate **OR** Built in, **as directed**.
  - c. Accessories: Continuous removable leaf screen with sheet metal frame and hardware cloth screen **OR** Wire ball downspout strainer **OR** Valley baffles, **as directed**.
  - d. Gutters with Girth up to 15 Inches (380 mm): Fabricate from the following materials:
    - 1) Copper: 16 oz./sq. ft. (0.55 mm thick).
    - 2) Aluminum: 0.032 inch (0.81 mm) thick.
    - 3) Stainless Steel: 0.016 inch (0.40 mm) thick.
    - 4) Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
    - 5) Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
    - 6) Galvanized Steel: 0.022 inch (0.56 mm) thick.
    - 7) Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
    - 8) Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
  - e. Gutters with Girth 16 to 20 Inches (410 to 510 mm): Fabricate from the following materials:
    - 1) Copper: 16 oz./sq. ft. (0.55 mm thick).
    - 2) Aluminum: 0.040 inch (1.02 mm) thick.
    - 3) Stainless Steel: 0.019 inch (0.48 mm) thick.
    - 4) Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
    - 5) Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
    - 6) Galvanized Steel: 0.028 inch (0.71 mm) thick.
    - 7) Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
    - 8) Zinc: 0.039 inch (1.00 mm) **OR** 0.048 inch (1.25 mm), **as directed**, thick.
  - f. Gutters with Girth 21 to 25 Inches (530 to 640 mm): Fabricate from the following materials:
    - 1) Copper: 20 oz./sq. ft. (0.68 mm thick).
    - 2) Aluminum: 0.050 inch (1.27 mm) thick.
    - 3) Stainless Steel: 0.025 inch (0.64 mm) thick.
    - 4) Zinc-Tin Alloy-Coated Stainless Steel: 0.024 inch (0.61 mm) thick.
    - 5) Zinc-Tin Alloy-Coated Copper: 20 oz./sq. ft. (0.68 mm thick).
    - 6) Galvanized Steel: 0.034 inch (0.86 mm) thick.
    - 7) Aluminum-Zinc Alloy-Coated Steel: 0.034 inch (0.86 mm) thick.
    - 8) Zinc: 0.048 inch (1.25 mm) **OR** 0.059 inch (1.50 mm), **as directed**, thick.
  - g. Gutters with Girth 26 to 30 Inches (660 to 760 mm): Fabricate from the following materials:
    - 1) Copper: 24 oz./sq. ft. (0.82 mm thick).
    - 2) Aluminum: 0.063 inch (1.60 mm) thick.
    - 3) Stainless Steel: 0.031 inch (0.79 mm) thick.
    - 4) Zinc-Tin Alloy-Coated Copper: 24 oz./sq. ft. (0.82 mm thick).
    - 5) Galvanized Steel: 0.040 inch (1.02 mm) thick.
    - 6) Aluminum-Zinc Alloy-Coated Steel: 0.040 inch (1.02 mm) thick.
  - h. Gutters with Girth 31 to 35 Inches (790 to 890 mm): Fabricate from the following materials:
    - 1) Copper: 24 oz./sq. ft. (0.82 mm thick).
    - 2) Stainless Steel: 0.038 inch (0.95 mm) thick.
    - 3) Zinc-Tin Alloy-Coated Copper: 25 oz./sq. ft. (0.87 mm thick).
    - 4) Galvanized Steel: 0.052 inch (1.32 mm) thick.
    - 5) Aluminum-Zinc Alloy-Coated Steel: 0.052 inch (1.32 mm) thick.



2. Built-in Gutters: Fabricate to cross section indicated, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required. Fabricate in minimum 96-inch- (2400-mm-) long sections. Fabricate expansion joints and accessories from same metal as gutters unless otherwise indicated.
  - a. Fabricate gutters with built-in expansion joints and gutter-end expansion joints at walls.
  - b. Accessories: Continuous removable leaf screen with sheet metal frame and hardware cloth screen **OR** Bronze wire ball downspout strainer **OR** Wire ball downspout strainer, **as directed**.
  - c. Fabricate from the following materials:
    - 1) Copper: 16 oz./sq. ft. (0.55 mm thick).
    - 2) Stainless Steel: 0.016 inch (0.40 mm) thick.
    - 3) Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
    - 4) Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
    - 5) Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
3. Downspouts: Fabricate round **OR** rectangular **OR** open-face, **as directed**, downspouts complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.
  - a. Fabricated Hanger Style: SMACNA figure designation 1-35A **OR** 1-35B **OR** 1-35C **OR** 1-35D **OR** 1-35E **OR** 1-35F **OR** 1-35G **OR** 1-35H **OR** 1-35I **OR** 1-35J, **as directed**.
  - b. Manufactured Hanger Style: SMACNA figure designation 1-34A **OR** 1-34B **OR** 1-34C **OR** 1-34D **OR** 1-34E, **as directed**.
  - c. Hanger Style: **<Insert description>**.
  - d. Fabricate from the following materials:
    - 1) Copper: 16 oz./sq. ft. (0.55 mm thick).
    - 2) Aluminum: 0.024 inch (0.61 mm) thick.
    - 3) Stainless Steel: 0.016 inch (0.40 mm) thick.
    - 4) Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
    - 5) Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
    - 6) Galvanized Steel: 0.022 inch (0.56 mm) thick.
    - 7) Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
    - 8) Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
4. Parapet Scuppers: Fabricate scuppers of dimensions required with closure flange trim to exterior, 4-inch- (100-mm-) wide wall flanges to interior, and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper. Fabricate from the following materials:
  - a. Copper: 16 oz./sq. ft. (0.55 mm thick).
  - b. Aluminum: 0.032 inch (0.81 mm) thick.
  - c. Stainless Steel: 0.019 inch (0.48 mm) thick.
  - d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
  - e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
  - f. Galvanized Steel: 0.028 inch (0.71 mm) thick.
  - g. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
  - h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
5. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape indicated complete with outlet tubes, exterior flange trim, and built-in overflows. Fabricate from the following materials:
  - a. Copper: 16 oz./sq. ft. (0.55 mm thick).
  - b. Aluminum: 0.032 inch (0.81 mm) thick.
  - c. Stainless Steel: 0.016 inch (0.40 mm) thick.
  - d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
  - e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
  - f. Galvanized Steel: 0.028 inch (0.71 mm) thick.
  - g. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
  - h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
6. Splash Pans: Fabricate from the following materials:



- a. Copper: 16 oz./sq. ft. (0.55 mm thick).
  - b. Aluminum: 0.040 inch (1.02 mm) thick.
  - c. Stainless Steel: 0.019 inch (0.48 mm) thick.
  - d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
  - e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
  - f. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
- G. Low-Slope Roof Sheet Metal Fabrications
1. Roof-Edge Flashing (Gravel Stop) and Fascia Cap: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 10-foot- (3-m-) long, sections. Furnish with 6-inch- (150-mm-) wide, joint cover plates.
    - a. Joint Style: Lap, 4 inches (100 mm) wide **OR** Butt, with 12-inch- (300-mm-) wide, concealed backup plate **OR** Butt, with 6-inch- (150-mm-) wide, exposed cover plates **OR** Butt, with 12-inch- (300-mm-) wide, concealed backup plate and 6-inch- (150-mm-) wide, exposed cover plates, **as directed**.
    - b. Fabricate with scuppers spaced 10 feet (3 m) apart, of dimensions required with 4-inch- (100-mm-) wide flanges and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper.
    - c. Fabricate from the following materials:
      - 1) Copper: 20 oz./sq. ft. (0.68 mm thick).
      - 2) Aluminum: 0.050 inch (1.27 mm) thick.
      - 3) Stainless Steel: 0.019 inch (0.48 mm) thick.
      - 4) Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
      - 5) Zinc-Tin Alloy-Coated Copper: 20 oz./sq. ft. (0.68 mm thick).
      - 6) Galvanized Steel: 0.028 inch (0.71 mm) thick.
      - 7) Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
      - 8) Zinc: 0.048 inch (1.25 mm) **OR** 0.059 inch (1.50 mm), **as directed**, thick.
  2. Copings: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 10-foot- (3-m-) long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, seal, and solder or weld watertight.
    - a. Coping Profile: SMACNA figure designation 3-4A **OR** 3-4B **OR** 3-4C **OR** 3-4D **OR** 3-4E **OR** 3-4F **OR** 3-4G, **as directed**.
    - b. Joint Style: Butt, with 12-inch- (300-mm-) wide, concealed backup plate **OR** Butt, with 6-inch- (150-mm-) wide, exposed cover plates **OR** Butt, with 12-inch- (300-mm-) wide, concealed backup plate and 6-inch- (150-mm-) wide, exposed cover plates, **as directed**.
    - c. Fabricate from the following materials:
      - 1) Copper: 24 oz./sq. ft. (0.82 mm thick).
      - 2) Aluminum: 0.050 inch (1.27 mm) thick.
      - 3) Stainless Steel: 0.025 inch (0.64 mm) thick.
      - 4) Zinc-Tin Alloy-Coated Stainless Steel: 0.024 inch (0.61 mm) thick.
      - 5) Zinc-Tin Alloy-Coated Copper: 24 oz./sq. ft. (0.82 mm thick).
      - 6) Galvanized Steel: 0.040 inch (1.02 mm) thick.
      - 7) Aluminum-Zinc Alloy-Coated Steel: 0.040 inch (1.02 mm) thick.
      - 8) Zinc: 0.048 inch (1.25 mm) **OR** 0.059 inch (1.50 mm), **as directed**, thick.
  3. Roof and Roof to Wall Transition **OR** Roof to Roof Edge Flashing (Gravel Stop) Transition **OR** Roof to Roof Edge Flashing (Gravel Stop) and Fascia Cap Transition, **as directed**, Expansion-Joint Cover: Fabricate from the following materials:
    - a. Copper: 16 oz./sq. ft. (0.55 mm thick).
    - b. Aluminum: 0.050 inch (1.27 mm) thick.
    - c. Stainless Steel: 0.025 inch (0.64 mm) thick.
    - d. Zinc-Tin Alloy-Coated Stainless Steel: 0.024 inch (0.61 mm) thick.
    - e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick)>.
    - f. Galvanized Steel: 0.034 inch (0.86 mm) thick.
    - g. Aluminum-Zinc Alloy-Coated Steel: 0.034 inch (0.86 mm) thick.
    - h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.



4. Base Flashing: Fabricate from the following materials:
    - a. Copper: 20 oz./sq. ft. (0.68 mm thick)>.
    - b. Aluminum: 0.040 inch (1.02 mm) thick.
    - c. Stainless Steel: 0.019 inch (0.48 mm) thick.
    - d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
    - e. Zinc-Tin Alloy-Coated Copper: 20 oz./sq. ft. (0.68 mm thick)>.
    - f. Galvanized Steel: 0.028 inch (0.71 mm) thick.
    - g. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
    - h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
  5. Counterflashing: Fabricate from the following materials:
    - a. Copper: 16 oz./sq. ft. (0.55 mm thick).
    - b. Aluminum: 0.032 inch (0.81 mm) thick.
    - c. Stainless Steel: 0.019 inch (0.48 mm) thick.
    - d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
    - e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick)>.
    - f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
    - g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
    - h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
  6. Flashing Receivers: Fabricate from the following materials:
    - a. Copper: 16 oz./sq. ft. (0.55 mm thick).
    - b. Aluminum: 0.032 inch (0.81 mm) thick.
    - c. Stainless Steel: 0.016 inch (0.40 mm) thick.
    - d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
    - e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
    - f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
    - g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
    - h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
  7. Roof-Penetration Flashing: Fabricate from the following materials:
    - a. Copper: 16 oz./sq. ft. (0.55 mm thick).
    - b. Stainless Steel: 0.019 inch (0.48 mm) thick.
    - c. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
    - d. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
    - e. Galvanized Steel: 0.028 inch (0.71 mm) thick.
    - f. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
    - g. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
  8. Roof-Drain Flashing: Fabricate from the following materials:
    - a. Copper: 12 oz./sq. ft. (0.41 mm thick).
    - b. Stainless Steel: 0.016 inch (0.40 mm) thick.
    - c. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
- H. Steep-Slope Roof Sheet Metal Fabrications
1. Apron, Step, Cricket, and Backer Flashing: Fabricate from the following materials:
    - a. Copper: 16 oz./sq. ft. (0.55 mm thick).
    - b. Aluminum: 0.032 inch (0.81 mm) thick.
    - c. Stainless Steel: 0.016 inch (0.40 mm) thick.
    - d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
    - e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
    - f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
    - g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
    - h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
  2. Valley Flashing: Fabricate from the following materials:
    - a. Copper: 16 oz./sq. ft. (0.55 mm thick).
    - b. Stainless Steel: 0.019 inch (0.48 mm) thick.
    - c. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
    - d. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).



- e. Galvanized Steel: 0.028 inch (0.71 mm) thick.
  - f. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
  - g. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
  3. Drip Edges: Fabricate from the following materials:
    - a. Copper: 16 oz./sq. ft. (0.55 mm thick).
    - b. Aluminum: 0.032 inch (0.81 mm) thick.
    - c. Stainless Steel: 0.016 inch (0.40 mm) thick.
    - d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
    - e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
    - f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
    - g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
    - h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
  4. Eave, Rake, Ridge, and Hip Flashing: Fabricate from the following materials:
    - a. Copper: 16 oz./sq. ft. (0.55 mm thick).
    - b. Aluminum: 0.032 inch (0.81 mm) thick.
    - c. Stainless Steel: 0.016 inch (0.40 mm) thick.
    - d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
    - e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
    - f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
    - g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
    - h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
  5. Counterflashing: Fabricate from the following materials:
    - a. Copper: 16 oz./sq. ft. (0.55 mm thick).
    - b. Aluminum: 0.032 inch (0.81 mm) thick.
    - c. Stainless Steel: 0.019 inch (0.48 mm) thick.
    - d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
    - e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
    - f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
    - g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
    - h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
  6. Flashing Receivers: Fabricate from the following materials:
    - a. Copper: 16 oz./sq. ft. (0.55 mm thick).
    - b. Aluminum: 0.032 inch (0.81 mm) thick.
    - c. Stainless Steel: 0.016 inch (0.40 mm) thick.
    - d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
    - e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
    - f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
    - g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
    - h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
  7. Roof-Penetration Flashing: Fabricate from the following materials:
    - a. Copper: 16 oz./sq. ft. (0.55 mm thick).
    - b. Stainless Steel: 0.019 inch (0.48 mm) thick.
    - c. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
    - d. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick)>.
    - e. Galvanized Steel: 0.028 inch (0.71 mm) thick.
    - f. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
    - g. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
- I. Wall Sheet Metal Fabrications
1. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long, sections, under copings, at shelf angles, and where indicated. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches (150 mm) beyond each side of wall openings. Form with 2-inch- (50-mm-) high, end dams where flashing is discontinuous. Fabricate from the following materials:
    - a. Copper: 16 oz./sq. ft. (0.55 mm thick).
    - b. Stainless Steel: 0.016 inch (0.40 mm) thick.



- c. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
- d. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
- e. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
- 2. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches (100 mm) beyond wall openings. Form head and sill flashing with 2-inch- (50-mm-) high, end dams. Fabricate from the following materials:
  - a. Copper: 16 oz./sq. ft. (0.55 mm thick).
  - b. Aluminum: 0.032 inch (0.81 mm) thick.
  - c. Stainless Steel: 0.016 inch (0.40 mm) thick.
  - d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
  - e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
  - f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
  - g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
  - h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
- 3. Wall Expansion-Joint Cover: Fabricate from the following materials:
  - a. Copper: 16 oz./sq. ft. (0.55 mm thick).
  - b. Aluminum: 0.040 inch (1.02 mm) thick.
  - c. Stainless Steel: 0.019 inch (0.48 mm) thick.
  - d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
  - e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
  - f. Galvanized Steel: 0.028 inch (0.71 mm) thick.
  - g. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
  - h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.

#### J. Miscellaneous Sheet Metal Fabrications

- 1. Equipment Support Flashing: Fabricate from the following materials:
  - a. Copper: 16 oz./sq. ft. (0.55 mm thick).
  - b. Stainless Steel: 0.019 inch (0.48 mm) thick.
  - c. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
  - d. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
  - e. Galvanized Steel: 0.028 inch (0.71 mm) thick.
  - f. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
- 2. Overhead-Piping Safety Pans: Fabricate from the following materials:
  - a. Copper: 24 oz./sq. ft. (0.82 mm thick).
  - b. Stainless Steel: 0.025 inch (0.64 mm) thick.
  - c. Zinc-Tin Alloy-Coated Stainless Steel: 0.024 inch (0.61 mm) thick.
  - d. Zinc-Tin Alloy-Coated Copper: 24 oz./sq. ft. (0.82 mm thick).
  - e. Galvanized Steel: 0.040 inch (1.02 mm) thick.
  - f. Aluminum-Zinc Alloy-Coated Steel: 0.040 inch (1.02 mm) thick.

### 1.3 EXECUTION

#### A. Underlayment Installation

- 1. General: Install underlayment as indicated on Drawings.
- 2. Polyethylene Sheet: Install polyethylene sheet with adhesive for anchorage to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped and taped joints of not less than 2 inches (50 mm).
- 3. Felt Underlayment: Install felt underlayment with adhesive for temporary anchorage to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).
- 4. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not



less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.

B. Installation, General

1. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
  - a. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
  - b. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
  - c. Space cleats not more than 12 inches (300 mm) apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
  - d. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
  - e. Install sealant tape where indicated.
  - f. Torch cutting of sheet metal flashing and trim is not permitted.
  - g. Do not use graphite pencils to mark metal surfaces.
2. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
  - a. Coat back side of uncoated aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
  - b. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.
3. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
4. Fastener Sizes: Use fasteners of sizes that will penetrate wood sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws **OR** metal decking not less than recommended by fastener manufacturer to achieve maximum pull-out resistance, **as directed**.
5. Seal joints as shown and as required for watertight construction.
  - a. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
  - b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".
6. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm), except reduce pre-tinning where pre-tinned surface would show in completed Work.
  - a. Do not solder metallic-coated steel and aluminum sheet.
  - b. Pre-tinning is not required for zinc-tin alloy-coated stainless steel and zinc-tin alloy-coated copper.
  - c. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.



- d. Stainless-Steel Soldering: Tin edges of uncoated sheets using solder recommended for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
- e. Copper Soldering: Tin edges of uncoated copper sheets using solder for copper.
- 7. Rivets: Rivet joints in uncoated aluminum **OR** zinc, **as directed**, where indicated and where necessary for strength.

### C. Roof Drainage System Installation

1. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.
2. Hanging Gutters: Join sections with riveted and soldered joints or with lapped joints sealed with sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchored gutter brackets **OR** straps **OR** twisted straps, **as directed**, spaced not more than 36 inches (900 mm) apart. Provide end closures and seal watertight with sealant. Slope to downspouts.
  - a. Fasten gutter spacers to front and back of gutter.
  - b. Loosely lock straps to front gutter bead and anchor to roof deck.
  - c. Anchor and loosely lock back edge of gutter to continuous cleat **OR** eave or apron flashing, **as directed**.
  - d. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches (600 mm) apart.
  - e. Anchor gutter with spikes and ferrules spaced not more than 24 inches (600 mm) **OR** 30 inches (750 mm), **as directed**, apart.
  - f. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet (15.24 m) apart. Install expansion-joint caps.
  - g. Install continuous gutter screens on gutters with noncorrosive fasteners, removable **OR** hinged to swing open, **as directed**, for cleaning gutters.
3. Built-in Gutters: Join sections with riveted and soldered or lapped joints sealed with sealant. Provide for thermal expansion. Slope to downspouts. Provide end closures and seal watertight with sealant.
  - a. Install felt underlayment layer in built-in gutter trough and extend to drip edge at eaves and under felt underlayment on roof sheathing. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with roofing nails. Install slip sheet over felt underlayment.
  - b. Anchor and loosely lock back edge of gutter to continuous cleat **OR** eave or apron flashing, **as directed**.
  - c. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches (600 mm) apart.
  - d. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet (15.24 m) apart. Install expansion-joint caps.
4. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints.
  - a. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches (1500 mm) o.c. in between.
  - b. Provide elbows at base of downspout to direct water away from building.
  - c. Connect downspouts to underground drainage system indicated.
5. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in asphalt roofing cement **OR** elastomeric sealant, **as directed**, compatible with roofing membrane.
6. Parapet Scuppers: Install scuppers where indicated through parapet. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
  - a. Anchor scupper closure trim flange to exterior wall and solder or seal with elastomeric sealant to scupper.
  - b. Loosely lock front edge of scupper with conductor head.



- c. Solder or seal with elastomeric sealant exterior wall scupper flanges into back of conductor head.
  7. Conductor Heads: Anchor securely to wall with elevation of conductor head rim 1 inch (25 mm) below scupper **OR** gutter, **as directed**, discharge.
  8. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated. Lap joints a minimum of 4 inches (100 mm) in direction of water flow.
- D. Roof Flashing Installation
1. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
  2. Roof Edge Flashing:
    - a. Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch (75-mm) centers.  
**OR**  
Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at 24-inch (600-mm) **OR** 16-inch (400-mm), **as directed**, centers.
  3. Copings: Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated.
    - a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 24-inch (600-mm) **OR** 16-inch (400-mm), **as directed**, centers.
    - b. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24-inch (600-mm) centers.
  4. Copings: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.
    - a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 24-inch (600-mm) **OR** 16-inch (400-mm), **as directed**, centers.
    - b. Anchor interior leg of coping with screw fasteners and washers at 24-inch (600-mm) **OR** 20-inch (500-mm), **as directed**, centers.
  5. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches (100 mm) over base flashing. Install stainless-steel draw band and tighten.
  6. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches (100 mm) over base flashing. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with sealant. Secure in a waterproof manner by means of snap-in installation and sealant or lead wedges and sealant **OR** interlocking folded seam or blind rivets and sealant **OR** anchor and washer at 36-inch (900-mm) centers, **as directed**.
  7. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric **OR** butyl, **as directed**, sealant and clamp flashing to pipes that penetrate roof.
- E. Wall Flashing Installation
1. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
  2. Through-Wall Flashing: Installation of through-wall flashing is specified in Division 04 Section(s) "Unit Masonry" **OR** "Stone Masonry", **as directed**.
  3. Reglets: Installation of reglets is specified in Division 03 Section(s) "Cast-in-place Concrete" **OR** Division 04 Section(s) "Unit Masonry", **as directed**.



4. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches (100 mm) beyond wall openings.

F. Miscellaneous Flashing Installation

1. Overhead-Piping Safety Pans: Suspend pans independent from structure above as indicated on Drawings. Pipe and install drain line to plumbing waste or drainage system.
2. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

G. Erection Tolerances

1. Installation Tolerances:
  - a. Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

**OR**

Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

H. Cleaning And Protection

1. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
2. Clean and neutralize flux materials. Clean off excess solder.
3. Clean off excess sealants.
4. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, remove unused materials and clean finished surfaces. Maintain in a clean condition during construction.
5. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 62 00 00

**SECTION 07 63 00 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION**

## 1.1 GENERAL

## A. Description Of Work

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

## B. Summary

1. This Section includes the following:
  - a. Piping materials and installation instructions common to most piping systems.
  - b. Mechanical sleeve seals.
  - c. Sleeves.
  - d. Escutcheons.
  - e. Grout.
  - f. Fire-suppression equipment and piping demolition.
  - g. Equipment installation requirements common to equipment sections.
  - h. Painting and finishing.
  - i. Concrete bases.
  - j. Supports and anchorages.

## C. Definitions

1. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
2. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
3. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
4. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
5. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
6. The following are industry abbreviations for plastic materials:
  - a. CPVC: Chlorinated polyvinyl chloride plastic.
7. The following are industry abbreviations for rubber materials:
  - a. EPDM: Ethylene-propylene-diene terpolymer rubber.
  - b. NBR: Acrylonitrile-butadiene rubber.

## D. Submittals

1. Welding certificates.

## E. Quality Assurance

1. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
2. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - a. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.



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

F. Delivery, Storage, And Handling

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

## 1.2 PRODUCTS

A. Pipe, Tube, And Fittings

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

B. Joining Materials

1. Refer to individual Division 28 for special joining materials not listed below.
2. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - a. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
    - 1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - 2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  - b. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
3. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
4. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
5. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
6. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
7. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
8. Solvent Cements for Joining CPVC Plastic Piping: ASTM F 493.

C. Mechanical Sleeve Seals

1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**. Include two for each sealing element.
  - c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements. Include one for each sealing element.

D. Sleeves

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



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

#### E. Escutcheons

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

#### F. Grout

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

### 1.3 EXECUTION

#### A. Fire-Suppression Demolition

1. Refer to Division 01 Section(s) "Cutting And Patching" AND Division 02 Section(s) "Selective Structure Demolition" for general demolition requirements and procedures.
2. Disconnect, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed.
  - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
  - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to the Owner.
3. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.



## B. Piping Systems - Common Requirements

1. Install piping according to the following requirements and Division 28 specifying piping systems.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
3. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
6. Install piping to permit valve servicing.
7. Install piping at indicated slopes.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.
10. Install piping to allow application of insulation.
11. Select system components with pressure rating equal to or greater than system operating pressure.
12. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
  - a. New Piping:
    - 1) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - 2) Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
    - 3) Insulated Piping: One-piece, stamped-steel type with spring clips.
    - 4) Bare Piping at Wall and Floor Penetrations in Finished Spaces:
      - a) One-piece, cast-brass type with polished chrome-plated finish.  
**OR**  
One-piece, stamped-steel type.
    - 5) Bare Piping at Ceiling Penetrations in Finished Spaces:
      - a) One-piece **OR** Split-casting, **as directed**, cast-brass type with polished chrome-plated finish.  
**OR**  
One-piece, stamped-steel type **OR** Split-plate, stamped-steel type with concealed hinge, **as directed**, and set screw.
    - 6) Bare Piping in Unfinished Service Spaces:
      - a) One-piece, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.  
**OR**  
One-piece, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw **OR** spring clips, **as directed**.
    - 7) Bare Piping in Equipment Rooms:
      - a) One-piece, cast-brass type.  
  
One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.
    - 8) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
  - b. Existing Piping: Use the following:
    - c. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
    - d. Insulated Piping: Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
    - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces:
      - 1) Split-casting, cast-brass type with chrome-plated finish.  
**OR**  
Split-plate, stamped-steel type with concealed hinge and spring clips.



- f. Bare Piping at Ceiling Penetrations in Finished Spaces:
    - 1) Split-casting, cast-brass type with chrome-plated finish.  
**OR**  
Split-plate, stamped-steel type with concealed hinge and set screw.
  - g. Bare Piping in Unfinished Service Spaces:
    - 1) Split-casting, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.  
**OR**  
Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw or spring clips.
  - h. Bare Piping in Equipment Rooms:
    - 1) Split-casting, cast-brass type.  
**OR**  
Split-plate, stamped-steel type with set screw or spring clips.
  - i. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
13. Sleeves are not required for core-drilled holes.
14. Permanent sleeves are not required for holes formed by removable PE sleeves.
15. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
16. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- a. Cut sleeves to length for mounting flush with both surfaces.
    - 1) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - b. Install sleeves in new walls and slabs as new walls and slabs are constructed.
  - c. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    - 1) PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
    - 2) Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
    - 3) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
      - a) Seal space outside of sleeve fittings with grout.
  - d. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
17. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- a. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
  - b. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
  - c. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
18. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- a. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.



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

#### C. Piping Joint Construction

1. Join pipe and fittings according to the following requirements and Division 28 specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
6. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
7. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Para. 1.1 "Quality Assurance" Article.
8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
9. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
10. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

#### D. Painting

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

#### E. Concrete Bases

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



- g. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".
  
- F. Erection Of Metal Supports And Anchorages
  - 1. Refer to Division 05 Section "Metal Fabrications" for structural steel.
  - 2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.
  - 3. Field Welding: Comply with AWS D1.1.
  
- G. Erection Of Wood Supports And Anchorages
  - 1. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor fire-suppression materials and equipment.
  - 2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
  - 3. Attach to substrates as required to support applied loads.
  
- H. Grouting
  - 1. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.
  - 2. Clean surfaces that will come into contact with grout.
  - 3. Provide forms as required for placement of grout.
  - 4. Avoid air entrapment during placement of grout.
  - 5. Place grout, completely filling equipment bases.
  - 6. Place grout on concrete bases and provide smooth bearing surface for equipment.
  - 7. Place grout around anchors.
  - 8. Cure placed grout.

END OF SECTION 07 63 00 00



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**SECTION 07 63 00 00a - COMMON WORK RESULTS FOR PLUMBING**

## 1.1 GENERAL

## A. Description Of Work

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

## B. Summary

1. This Section includes the following:
  - a. Piping materials and installation instructions common to most piping systems.
  - b. Transition fittings.
  - c. Dielectric fittings.
  - d. Mechanical sleeve seals.
  - e. Sleeves.
  - f. Escutcheons.
  - g. Grout.
  - h. Plumbing demolition.
  - i. Equipment installation requirements common to equipment sections.
  - j. Painting and finishing.
  - k. Concrete bases.
  - l. Supports and anchorages.

## C. Definitions

1. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
2. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
3. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
4. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
5. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
6. The following are industry abbreviations for plastic materials:
  - a. ABS: Acrylonitrile-butadiene-styrene plastic.
  - b. CPVC: Chlorinated polyvinyl chloride plastic.
  - c. PE: Polyethylene plastic.
  - d. PVC: Polyvinyl chloride plastic.
7. The following are industry abbreviations for rubber materials:
  - a. EPDM: Ethylene-propylene-diene terpolymer rubber.
  - b. NBR: Acrylonitrile-butadiene rubber.

## D. Submittals

1. Welding certificates.

## E. Quality Assurance

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



2. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - a. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
3. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

F. Delivery, Storage, And Handling

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

## 1.2 PRODUCTS

A. Pipe, Tube, And Fittings

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

B. Joining Materials

1. Refer to individual Division 14 for special joining materials not listed below.
2. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - a. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
    - 1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - 2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  - b. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
3. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
4. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
5. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
6. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
7. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
8. Solvent Cements for Joining Plastic Piping:
  - a. ABS Piping: ASTM D 2235.
  - b. CPVC Piping: ASTM F 493.
  - c. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
  - d. PVC to ABS Piping Transition: ASTM D 3138.
9. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

C. Transition Fittings

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



- b. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve-type coupling.
  - c. Aboveground Pressure Piping: Pipe fitting.
  2. Plastic-to-Metal Transition Fittings: CPVC **OR** PVC, **as directed**, one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
  3. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
  4. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC **OR** PVC, **as directed**, four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
  5. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
- D. Dielectric Fittings
1. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
  2. Insulating Material: Suitable for system fluid, pressure, and temperature.
  3. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
  4. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
  5. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
    - a. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.
  6. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
  7. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
- E. Mechanical Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
    - a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
    - b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**. Include two for each sealing element.
    - c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements. Include one for each sealing element.
- F. Sleeves
1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
  2. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
  3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
  4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
    - a. Underdeck Clamp: Clamping ring with set screws.
  5. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
  6. PVC Pipe: ASTM D 1785, Schedule 40.



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

#### G. Escutcheons

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

#### H. Grout

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

### 1.3 EXECUTION

#### A. Plumbing Demolition

1. Refer to Division 01 Section(s) "Cutting And Patching" AND Division 02 Section(s) "Selective Structure Demolition" for general demolition requirements and procedures.
2. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
  - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
  - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to the Owner.
3. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

#### B. Piping Systems - Common Requirements

1. Install piping according to the following requirements and Division 14 specifying piping systems.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.



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



- Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw or spring clips.
- 6) Bare Piping in Equipment Rooms:
    - a) Split-casting, cast-brass type.  
**OR**  
Split-plate, stamped-steel type with set screw or spring clips.
  - 7) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
13. Sleeves are not required for core-drilled holes.
  14. Permanent sleeves are not required for holes formed by removable PE sleeves.
  15. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
  16. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
    - a. Cut sleeves to length for mounting flush with both surfaces.
      - 1) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
    - b. Install sleeves in new walls and slabs as new walls and slabs are constructed.
    - c. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      - 1) PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
      - 2) Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
      - 3) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
        - a) Seal space outside of sleeve fittings with grout.
    - d. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
  17. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
    - a. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
    - b. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
    - c. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
  18. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
    - a. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
  19. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
  20. Verify final equipment locations for roughing-in.
  21. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

**C. Piping Joint Construction**

1. Join pipe and fittings according to the following requirements and Division 14 specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
6. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
7. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Para. 1.1 "Quality Assurance" Article.
8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
9. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - b. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
  - c. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  - d. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
  - e. PVC Nonpressure Piping: Join according to ASTM D 2855.
  - f. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
10. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
11. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
12. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
  - a. Plain-End Pipe and Fittings: Use butt fusion.
  - b. Plain-End Pipe and Socket Fittings: Use socket fusion.
13. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

**D. Piping Connections**

1. Make connections according to the following, unless otherwise indicated:
  - a. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - b. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
  - c. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
  - d. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

**E. Equipment Installation - Common Requirements**

1. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.



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

#### F. Painting

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

#### G. Concrete Bases

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

#### H. Erection Of Metal Supports And Anchorages

1. Refer to Division 05 Section "Metal Fabrications" for structural steel.
2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
3. Field Welding: Comply with AWS D1.1.

#### I. Erection Of Wood Supports And Anchorages

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

#### J. Grouting

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



END OF SECTION 07 63 00 00a



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**SECTION 07 63 00 00b - COMMON WORK RESULTS FOR HVAC**

## 1.1 GENERAL

## A. Description Of Work

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

## B. Summary

1. This Section includes the following:
  - a. Piping materials and installation instructions common to most piping systems.
  - b. Transition fittings.
  - c. Dielectric fittings.
  - d. Mechanical sleeve seals.
  - e. Sleeves.
  - f. Escutcheons.
  - g. Grout.
  - h. HVAC demolition.
  - i. Equipment installation requirements common to equipment sections.
  - j. Painting and finishing.
  - k. Concrete bases.
  - l. Supports and anchorages.

## C. Definitions

1. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
2. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
3. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
4. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
5. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
6. The following are industry abbreviations for plastic materials:
  - a. CPVC: Chlorinated polyvinyl chloride plastic.
  - b. PE: Polyethylene plastic.
  - c. PVC: Polyvinyl chloride plastic.
7. The following are industry abbreviations for rubber materials:
  - a. EPDM: Ethylene-propylene-diene terpolymer rubber.
  - b. NBR: Acrylonitrile-butadiene rubber.

## D. Submittals

1. Welding certificates.

## E. Quality Assurance

1. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
2. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."



- a. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
3. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

F. Delivery, Storage, And Handling

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

## 1.2 PRODUCTS

A. Pipe, Tube, And Fittings

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

B. Joining Materials

1. Refer to individual Division 21 for special joining materials not listed below.
2. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - a. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
    - 1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - 2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  - b. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
3. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
4. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
5. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
6. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
7. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
8. Solvent Cements for Joining Plastic Piping:
  - a. CPVC Piping: ASTM F 493.
  - b. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
9. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

C. Transition Fittings

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



- D. Dielectric Fittings
1. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
  2. Insulating Material: Suitable for system fluid, pressure, and temperature.
  3. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
  4. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
  5. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
    - a. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.
  6. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
  7. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
- E. Mechanical Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
    - a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
    - b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**. Include two for each sealing element.
    - c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements. Include one for each sealing element.
- F. Sleeves
1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
  2. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
  3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
  4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
    - a. Underdeck Clamp: Clamping ring with set screws.
  5. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
  6. PVC Pipe: ASTM D 1785, Schedule 40.
  7. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.
- G. Escutcheons
1. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
  2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
  3. One-Piece, Cast-Brass Type: With set screw.
    - a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.
  4. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
    - a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.



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

#### H. Grout

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

### 1.3 EXECUTION

#### A. HVAC Demolition

1. Refer to Division 01 Section(s) "Cutting And Patching" AND Division 02 Section(s) "Selective Structure Demolition" for general demolition requirements and procedures.
2. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
  - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
  - c. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
  - d. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
  - e. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  - f. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - g. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to the Owner.
3. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

#### B. Piping Systems - Common Requirements

1. Install piping according to the following requirements and Division 21 specifying piping systems.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
3. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
6. Install piping to permit valve servicing.
7. Install piping at indicated slopes.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.



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



15. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
16. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
  - a. Cut sleeves to length for mounting flush with both surfaces.
    - 1) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - b. Install sleeves in new walls and slabs as new walls and slabs are constructed.
  - c. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    - 1) PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
    - 2) Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
    - 3) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
      - a) Seal space outside of sleeve fittings with grout.
  - d. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
17. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - a. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
  - b. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
  - c. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
18. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - a. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
19. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
20. Verify final equipment locations for roughing-in.
21. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

#### C. Piping Joint Construction

1. Join pipe and fittings according to the following requirements and Division 21 specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.



6. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
  7. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Para. 1.1 "Quality Assurance" Article.
  8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
  9. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    - a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    - b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
    - c. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
    - d. PVC Nonpressure Piping: Join according to ASTM D 2855.
  10. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
  11. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
  12. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
    - a. Plain-End Pipe and Fittings: Use butt fusion.
    - b. Plain-End Pipe and Socket Fittings: Use socket fusion.
  13. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.
- D. Piping Connections
1. Make connections according to the following, unless otherwise indicated:
    - a. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
    - b. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
    - c. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
    - d. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.
- E. Equipment Installation - Common Requirements
1. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
  2. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
  3. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
  4. Install equipment to allow right of way for piping installed at required slope.
- F. Painting
1. Painting of HVAC systems, equipment, and components is specified in Division 09 Section(s) "Exterior Painting" AND "Interior Painting".
  2. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.



#### G. Concrete Bases

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

#### H. Erection Of Metal Supports And Anchorages

1. Refer to Division 05 Section "Metal Fabrications" for structural steel.
2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
3. Field Welding: Comply with AWS D1.1.

#### I. Erection Of Wood Supports And Anchorages

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

#### J. Grouting

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

END OF SECTION 07 63 00 00b



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
07 63 00 00	07 62 00 00	Sheet Metal Flashing And Trim

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**SECTION 07 65 16 00 - BUILT-UP ASPHALT ROOFING**

## 1.1 GENERAL

## A. Description Of Work:

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

## B. Summary

1. Section Includes:
  - a. Built-up asphalt roofing.
  - b. Vapor retarder.
  - c. Roof insulation.
2. Section includes the installation of insulation strips in ribs of acoustical roof deck. Insulation strips are furnished under Division 5 Section "Steel Deck."

## C. Definitions

1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to built-up roofing.
2. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mop-applied roofing asphalt and 75 centipoise for mechanical spreader-applied roofing asphalt, within a range of plus or minus 25 deg F (14 deg C), measured at the mop cart or mechanical spreader immediately before application.

## D. Performance Requirements

1. General Performance: Installed built-up roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Built-up roofing and base flashings shall remain watertight.
2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by built-up roofing manufacturer based on testing and field experience.
3. Roofing System Design: Provide built-up roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
4. FM Approvals Listing: Provide built-up roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a built-up roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
  - a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120, **as directed.**
  - b. Hail Resistance Rating: MH **OR** SH, **as directed.**
5. Energy Performance (for LEED-NC Credit SS 7.2): Provide roofing system with initial Solar Reflectance Index not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.
6. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
7. Energy Performance (for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

## E. Submittals



1. Product Data: For each type of product indicated.
2. LEED Submittals:
  - a. Product Test Reports for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
  - b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For built-up roofing. Include plans, elevations, sections, details, and attachments to other work.
  - a. Base flashings and built-up terminations.
  - b. Tapered insulation, including slopes.
  - c. Crickets, saddles, and tapered edge strips, including slopes.
  - d. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
4. Samples: For the following products:
  - a. Built-up roofing materials, including base sheet, ply sheet, cap sheet, and flashing sheet, of color specified.
  - b. Roof insulation.
  - c. 3 lb (1.5 kg) of aggregate surfacing material in gradation and color indicated.
  - d. Roof paver, full sized, in each color and texture required.
  - e. Walkway pads.
  - f. Six insulation fasteners of each type, length, and finish.
5. Qualification Data: For qualified Installer and manufacturer.
6. Manufacturer Certificates: Signed by roofing manufacturer certifying that built-up roofing complies with requirements specified in "Performance Requirements" Article.
  - a. Submit evidence of compliance with performance requirements.
7. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of built-up roofing.
8. Research/Evaluation Reports: For components of built-up roofing, from the ICC-ES.
9. Maintenance Data: For built-up roofing to include in maintenance manuals.
10. Warranties: Sample of special warranties.

#### F. Quality Assurance

1. Manufacturer Qualifications: A qualified manufacturer that is UL listed **OR** FM Approvals approved, **as directed**, for built-up roofing identical to that used for this Project.
2. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by built-up roofing manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
3. Source Limitations: Obtain components including roof insulation and fasteners for built-up roofing from same manufacturer as built-up roofing or approved by built-up roofing manufacturer.
4. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical built-up roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
5. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
6. Preinstallation Roofing Conference: Conduct conference at Project site.

#### G. Delivery, Storage, And Handling

1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing manufacturer. Protect stored liquid material from direct sunlight.



- a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
  3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
  4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.
- H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be installed according to manufacturer's written instructions and warranty requirements.
- I. Warranty
1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of built-up roofing that fail in materials or workmanship within specified warranty period.
    - a. Special warranty includes built-up roofing membrane, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, roof pavers, and other components of built-up roofing.
    - b. Warranty Period: 10 **OR** 15 **OR** 20 **OR** 25 **OR** 30, **as directed**, years from date of Final Completion.
  2. Special Project Warranty: Submit roofing Installer's warranty, signed by Installer, covering the Work of this Section, including all components of built-up roofing such as built-up roofing membrane, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:
    - a. Warranty Period: Two years from date of Final Completion.

## 1.2 PRODUCTS

### A. Built-Up Roofing Manufacturers

### B. Base-Sheet Materials

1. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).
2. Base Sheet: ASTM D 4601, Type II, SBS-modified, asphalt-impregnated and -coated sheet, with glass-fiber-reinforcing mat, dusted with fine mineral surfacing on both sides.
  - a. Weight: 25 lb/100 sq. ft. (1.2 kg/sq. m) **OR** 40 lb/100 sq. ft. (1.95 kg/sq. m) **OR** 50 lb/100 sq. ft. (2.4 kg/sq. m) **OR** 60 lb/100 sq. ft. (3.0 kg/sq. m) **OR** 75 lb/100 sq. ft. (3.7 kg/sq. m), **as directed**, minimum.

**OR**

Base Sheet: ASTM D 4601, Type I **OR** II, **as directed**, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

**OR**

Base Sheet: ASTM D 4897, Type II, venting, nonperforated, heavyweight, asphalt-impregnated and -coated, glass-fiber base sheet with coarse granular surfacing or embossed venting channels on bottom surface.

**OR**

Base Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

### C. Roofing Membrane Plies

1. Ply Sheet: ASTM D 2178, Type IV **OR** VI, **as directed**, asphalt-impregnated, glass-fiber felt.
2. Cap Sheet: ASTM D 3909, asphalt-impregnated and -coated, glass-fiber cap sheet, with white coarse mineral-granule top surfacing and fine mineral surfacing on bottom surface.



D. Base Flashing Sheet Materials

1. Backer Sheet: ASTM D 2178, Type IV **OR** VI, **as directed**, asphalt-impregnated, glass-fiber felt.  
**OR**  
Backer Sheet: ASTM D 4601, Type I **OR** II, **as directed**, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.  
**OR**  
Backer Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.
2. Granule-Surfaced Flashing Sheet: ASTM D 6164, Grade G, Type I or II, polyester-reinforced **OR** ASTM D 6163, Grade G, Type I or II, glass-fiber-reinforced **OR** ASTM D 6162, Grade G, Type I or II, composite polyester-reinforced and glass-fiber-reinforced, **as directed**, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified, and as follows:
  - a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
3. Metal-Foil-Surfaced Flashing Sheet: ASTM D 6298, glass-fiber-reinforced, SBS-modified asphalt sheet; metal-foil surfaced; suitable for application method specified, and as follows:
  - a. Foil Surfacing: Aluminum **OR** Copper **OR** Stainless steel **OR** Aluminum, fluoropolymer coated finish, of color and gloss selected from manufacturer's full range, **as directed**.
4. Smooth-Surfaced Flashing Sheet: ASTM D 6222, Grade S, Type I or II, polyester-reinforced **OR** ASTM D 6223, Grade S, Type I or II, composite polyester-reinforced and glass-fiber-reinforced, **as directed**, APP-modified asphalt sheet; smooth surfaced; suitable for application method specified.  
**OR**  
Granule-Surfaced Flashing Sheet: ASTM D 6222, Grade G, Type I or II, polyester-reinforced **OR** ASTM D 6223, Grade G, Type I or II, composite polyester-reinforced and glass-fiber-reinforced, **as directed**, APP-modified asphalt sheet; granular surfaced; suitable for application method specified, and as follows:
  - a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
5. Glass-Fiber Fabric: Woven glass-fiber cloth, treated with asphalt, complying with ASTM D 1668, Type I.

E. Asphalt Materials

1. Asphalt Primer: ASTM D 41.
2. Roofing Asphalt: ASTM D 312, Type III **OR** IV **OR** III or IV as recommended by built-up roofing manufacturer for application, **as directed**.
3. Roofing Asphalt: ASTM D 6152, SEBS modified.

F. Auxiliary Built-Up Roofing Materials

1. General: Auxiliary materials recommended by roofing manufacturer for intended use and compatible with built-up roofing.
  - a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
  - b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    - 1) Plastic Foam Adhesives: 50 g/L.
    - 2) Gypsum Board and Panel Adhesives: 50 g/L.
    - 3) Multipurpose Construction Adhesives: 70 g/L.
    - 4) Fiberglass Adhesives: 80 g/L.
    - 5) Contact Adhesives: 80 g/L.
    - 6) Other Adhesives: 250 g/L.
    - 7) Nonmembrane Roof Sealants: 300 g/L.
    - 8) Sealant Primers for Nonporous Substrates: 250 g/L.
    - 9) Sealant Primers for Porous Substrates: 775 g/L.



2. Cold-Applied Adhesive: Roofing manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with built-up base flashings.
3. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing manufacturer for application.
4. Mastic Sealant: Polyisobutylene, plain or modified bitumen, nonhardening, nonmigrating, nonskinning, and nondrying.
5. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening built-up roofing components to substrate, tested by manufacturer for required pullout strength, and acceptable to roofing manufacturer.
6. Metal Flashing Sheet: Metal flashing sheet is specified in Division 7 Section "Sheet Metal Flashing and Trim."
7. Aggregate Surfacing: ASTM D 1863, No. 6 or No. 67, clean, dry, opaque, water-worn gravel or crushed stone, free of sharp edges **OR** crushed slag, free of sharp edges, **as directed**.
8. Miscellaneous Accessories: Provide miscellaneous accessories recommended by built-up roofing manufacturer.

G. Substrate Boards

1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.  
**OR**  
Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.  
**OR**  
Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.  
**OR**  
Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

H. Vapor Retarder

1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
  - a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.  
**OR**  
Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
2. Laminated Sheet: Kraft paper/polyethylene laminate, two layers, reinforced with woven fiberglass yarn, laminated and edge reinforced, with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Self-Adhering Sheet Vapor Retarder: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, polyethylene film laminated to layer of rubberized asphalt adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold-applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.  
**OR**  
Self-Adhering Sheet Vapor Retarder: 30- to 40-mil- (0.76- to 1.0-mm-) thick, polyethylene film laminated to layer of butyl rubber adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold-applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.
4. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt impregnated.



### I. Roof Insulation

1. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) **OR** X, 1.3-lb/cu. ft. (21-kg/cu. m), **as directed**, minimum density, square edged.
3. Molded-Polystyrene Board Insulation: ASTM C 578 Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density.
4. Composite Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density, with factory-applied facings, as follows:
  - a. Facer: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.

**OR**

  - a. Facer: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
5. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
6. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board on one major surface as indicated below by type, and felt or glass-fiber mat facer on the other surface.
  - a. Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick.
  - b. Type V, OSB facer, 7/16 inch (11 mm) thick.
  - c. Type VII, glass mat faced gypsum board facer, 1/4 inch (6 mm) thick.
7. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
8. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
9. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
10. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.
11. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

### J. Insulation Accessories

1. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with built-up roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate and acceptable to roofing manufacturer.
3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphaltic, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
 

**OR**

Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.

**OR**

Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
4. Insulation Cant Strips: ASTM C 728, perlite insulation board.
5. Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.



6. Wood Nailer Strips: Comply with requirements in Division 6 Section "Rough Carpentry" **OR** "Miscellaneous Carpentry", **as directed**.
  7. Tapered Edge Strips: ASTM C 728, perlite insulation board.  
**OR**  
Tapered Edge Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
  8. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.  
**OR**  
Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.  
**OR**  
Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.  
**OR**  
Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
  9. Substrate Joint Tape: 6- or 8-inch- (150- or 200-mm-) wide, coated, glass fiber.
- K. Coating Materials
1. Roof Coating: ASTM D 1227, Type II Class 1, mineral-colloid-emulsified, fibered **OR** 2, chemically emulsified, filled or fibered, **as directed**, asphalt emulsion, asbestos free.  
**OR**  
Roof Coating: ASTM D 1227, Type III, Class 1, mineral-colloid-emulsified **OR** 2, chemically emulsified, **as directed**, asphalt emulsion, nonfibered.  
**OR**  
Roof Coating: ASTM D 2824, Type I, nonfibered **OR** III, fibered, asbestos-free, **as directed**, aluminum-pigmented asphaltic coating.  
**OR**  
Roof Coating: Acrylic elastomer emulsion coating, formulated for use on bituminous roof surfaces and complying with ASTM D 6083 **OR** the following, **as directed**:
    - a. Initial Percent Elongation (Break): Not less than 60 percent at 0 deg F (-18 deg C) and 200 percent at 73 deg F (23 deg C) when tested according to ASTM D 2370.
    - b. Initial Tensile Strength (Maximum Stress): Not less than 100 psi (1.38 MPa) at 73 deg F (23 deg C) and 200 psi (2.76 MPa) at 0 deg F (-18 deg C) when tested according to ASTM D 2370.
    - c. Final Percent Elongation (Break) after Accelerated Weathering 1000 hrs.: Not less than 40 percent at 0 deg F (-18 deg C) and 100 percent at 73 deg F (23 deg C) when tested according to ASTM D 2370.
    - d. Permeance: Not more than 50 perms when measured according to ASTM D 1653.
    - e. Accelerated Weathering 1000 hrs.: No cracking or checking when tested according to ASTM D 4798.
    - f. Color: White **OR** Gray **OR** Buff, **as directed**.
- L. Walkways
1. Walkway Pads: Mineral-granule-surfaced, reinforced asphaltic composition **OR** Polymer-modified, reconstituted solid-rubber, surface-textured, **as directed**, slip-resisting pads, manufactured as a traffic pad for foot traffic and acceptable to roofing manufacturer, 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, thick, minimum.
  2. Walkway Cap Sheet Strips: ASTM D 6164, Grade G, Type I or II, polyester-reinforced **OR** ASTM D 6163, Grade G, Type I or II, glass-fiber-reinforced **OR** ASTM D 6162, Grade G, Type I or II, composite polyester-reinforced and glass-fiber-reinforced, **as directed**, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified, and as follows:
    - a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
  3. Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not



greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:

- a. Size: 24 by 24 inches (600 by 600 mm). Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
- b. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum; ASTM C 140.
- c. Colors and Textures: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

### 1.3 EXECUTION

#### A. Examination

1. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
  - a. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
  - b. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
  - c. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section "Steel Decking".
  - d. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch (1.6 mm) out of plane relative to adjoining deck.
  - e. Verify that minimum concrete drying period recommended by roofing manufacturer has passed.
  - f. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
    - 1) Test for moisture by pouring 1 pint (0.5 L) of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if test sample foams or can be easily and cleanly stripped after cooling.
  - g. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### B. Preparation

1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Prime surface of concrete deck with asphalt primer at a rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
4. Install insulation strips in ribs of acoustical roof decks according to acoustical roof deck manufacturer's written instructions.

#### C. Substrate Board Installation

1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
  - a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.  
**OR**  
Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to built-up roofing manufacturer's written instructions.

**D. Vapor-Retarder Installation**

1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
  - a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.

**OR**

Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:

  - a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.

**OR**

Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.

**OR**

Self-Adhering Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches (90 mm) and 6 inches (150 mm), respectively. Seal laps by rolling.

**OR**

Built-up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
2. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into built-up roofing.

**E. Insulation Installation**

1. Comply with built-up roofing manufacturer's written instructions for installing roof insulation.
2. Install one lapped base sheet course and mechanically fasten to substrate according to built-up roofing manufacturer's written instructions.
3. Nailers Strips: Mechanically fasten 4-inch nominal- (89-mm actual-) width wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:
  - a. 16 feet (4.88 m) apart for roof slopes greater than 1 inch per 12 inches (1:12) but less than 3 inches per 12 inches (3:12).
  - b. 48 inches (1220 mm) apart for roof slopes greater 3 inches per 12 inches (3:12).
4. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of built-up roofing with vertical surfaces or angle changes greater than 45 degrees.
5. Install tapered insulation under area of roofing to conform to slopes indicated.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
  - a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
  - a. Where installing composite and noncomposite board insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
8. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
9. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
10. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
  - a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.



- b. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
- c. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.  
**OR**  
Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
- 11. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
  - a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
  - b. If number of fasteners will be based on ASCE/SEI 7's uplift pressure, fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
- 12. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
  - a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
  - b. If number of fasteners will be based on ASCE/SEI 7's uplift pressure, fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
  - c. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.  
**OR**  
Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.  
**OR**  
Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
- 13. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck, **as directed**. Tape joints if required by roofing manufacturer.
  - a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
  - b. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.
  - c. Apply hot roofing asphalt to underside and immediately bond cover board to substrate.

#### F. Built-Up Roofing Installation, General

- 1. Install roofing membrane according to roofing manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
  - a. Install roofing system BU-3 **OR** 4 **OR** 5, **as directed**, -N **OR** I **OR** C, **as directed**, -A-A **OR** S **OR** M, **as directed**, according to roof assembly identification matrix and roof assembly layout illustrations in NRCA's "The NRCA Roofing and Waterproofing Manual" and requirements in this Section.  
**OR**  
Install roofing membrane according to roofing manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing" and as follows:
    - a. Deck Type: N (nailable) **OR** I (insulated) **OR** C (concrete or nonnailable), **as directed**.
    - b. Base Sheet: 1 **OR** 1, installed over sheathing paper, **as directed**.
    - c. Number of Ply Sheets: 2 **OR** 3 **OR** 4, **as directed**.



- d. Surfacing Type: A (aggregate) **OR** S (asphalt surfacing or coating) **OR** M (mineral-granule-surfaced cap sheet), **as directed**.
    - 1) Mineral-granule-surfaced cap sheet is in addition to number of ply sheets specified.
  2. Start installation of built-up roofing in presence of manufacturer's technical personnel.
  3. Where roof slope exceeds 1/2 inch per 12 inches (1:24) **OR** 3/4 inch per 12 inches (1:18), **as directed**, install built-up roofing sheets parallel with slope.
    - a. Backnail built-up roofing sheets to nailer strips **OR** substrate, **as directed**, according to roofing manufacturer's written instructions.
  4. Cooperate with testing agencies engaged or required to perform services for installing roofing.
  5. Coordinate installation of roofing so insulation and other components of built-up roofing not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
    - a. Provide tie-offs at end of each day's work to cover exposed built-up roofing sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.
    - b. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing.
    - c. Remove and discard temporary seals before beginning work on adjoining roofing.
  6. Asphalt Heating: Do not raise roofing asphalt temperature above equiviscous temperature range more than one hour before time of application. Do not exceed roofing asphalt manufacturer's recommended temperature limits during roofing asphalt heating. Do not heat roofing asphalt within 25 deg F (14 deg C) of flash point. Discard roofing asphalt maintained at a temperature exceeding finished blowing temperature for more than 4 hours.

**OR**

Asphalt Heating: Heat and apply SEBS-modified roofing asphalt according to roofing manufacturer's written instructions.
  7. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging built-up roofing components or adjacent building construction.
- G. Roofing Membrane Installation
1. Loosely lay one course of sheathing paper, lapping edges and ends a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
  2. Install lapped base sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:
    - a. Mechanically fasten to substrate.

**OR**

Spot- or strip-mop to substrate with hot roofing asphalt.

**OR**

Adhere to substrate in a solid mopping of hot roofing asphalt, **as directed**.
  3. Install two **OR** three **OR** four, **as directed**, ply sheets starting at low point of roofing. Align ply sheets without stretching. Shingle side laps of ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane. Shingle in direction to shed water. Extend ply sheets over and terminate beyond cants.
    - a. Embed each ply sheet in a solid mopping of hot roofing asphalt applied at rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.
  4. Cap Sheet: Install lapped granulated cap sheet starting at low point of roofing. Offset laps from laps of preceding ply sheets and align cap sheet without stretching. Lap in direction to shed water. Extend cap sheet over and terminate beyond cants.
    - a. Embed cap sheet in a solid mopping of hot roofing asphalt applied at rate required by built-up roofing manufacturer.
  5. Aggregate Surfacing: Promptly after installing and testing roofing membrane, base flashing, and stripping, flood-coat roof surface with 60 lb/100 sq. ft. (3.0 kg/sq. m) of hot roofing asphalt. While flood coat is hot and fluid, cast the following average weight of aggregate in a uniform course:
    - a. Aggregate Weight: 400 lb/100 sq. ft. (20 kg/sq. m) **OR** 300 lb/100 sq. ft. (15 kg/sq. m), **as directed**.



- b. If aggregate surfacing is delayed, promptly apply glaze coat of hot roofing asphalt at a rate of 10 lb/100 sq. ft. (0.5 kg/sq. m).
- 6. Glaze-coat roofing membrane surface with hot roofing asphalt applied at a rate of 10 to 15 lb/100 sq. ft. (0.5 to 0.75 kg/sq. m).

#### H. Flashing And Stripping Installation

1. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to built-up roofing manufacturer's written instructions and as follows:
  - a. Prime substrates with asphalt primer if required by built-up roofing manufacturer.
  - b. Backer Sheet Application: Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over built-up roofing at cants in a solid mopping of hot roofing asphalt **OR** cold-applied adhesive, **as directed**.  
**OR**  
 Backer Sheet Application: Adhere backer sheet to substrate in a solid mopping of hot roofing asphalt **OR** cold-applied adhesive, **as directed**.
  - c. Flashing Sheet Application: Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C). Apply hot roofing asphalt to back of flashing sheet if recommended by roofing manufacturer.  
**OR**  
 Flashing Sheet Application: Adhere flashing sheet to substrate in cold-applied adhesive at rate required by roofing manufacturer.  
**OR**  
 Flashing Sheet Application: Adhere flashing sheet to substrate in asphalt roofing cement at rate required by roofing manufacturer.  
**OR**  
 Flashing Sheet Application: Torch apply flashing sheet to substrate.
2. Extend base flashing up walls or parapets a minimum of 8 inches (200 mm) above built-up roofing and 4 inches (100 mm) onto field of built-up roofing.
3. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.
  - a. Seal top termination of base flashing with a strip of glass-fiber fabric set in asphalt roofing cement.
4. Install stripping, according to roofing manufacturer's written instructions, where metal flanges and edgings are set on built-up roofing.
  - a. Flashing-Sheet Stripping: Install flashing-sheet stripping in a continuous coating of asphalt roofing cement or in a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C), and extend onto roofing membrane.  
**OR**  
 Flashing-Sheet Stripping: Install flashing-sheet stripping by heat welding and extend onto roofing membrane.  
**OR**  
 Built-up Stripping: Install stripping of not less than two roofing membrane ply sheets, setting each ply in a continuous coating of asphalt roofing cement or in a solid mopping of hot roofing asphalt, and extend onto roofing membrane 4 inches (100 mm) and 6 inches (150 mm), respectively.
5. Roof Drains: Set 30-by-30-inch (760-by-760-mm) metal flashing in bed of asphalt roofing cement on completed built-up roofing. Cover metal flashing with built-up roofing cap-sheet stripping and extend a minimum of 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, beyond edge of metal flashing onto field of built-up roofing. Clamp built-up roofing, metal flashing, and stripping into roof-drain clamping ring.
  - a. Install stripping according to roofing manufacturer's written instructions.

#### I. Coating Installation



1. Apply coating to built-up roofing and base flashings according to manufacturer's written instructions, by spray, roller, or other suitable application method to provide a dry film thickness of not less than 20 mils (0.5 mm).
- J. Walkway Installation
1. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size, according to walkway pad manufacturer's written instructions.
    - a. Set walkway pads in additional pour coat of hot roofing asphalt after sweeping away loose aggregate surfacing.
  2. Walkway Cap Sheet Strips: Install walkway cap sheet strips, approximately 36 inches (900 mm) wide and in lengths not exceeding 10 feet (3 m), leaving a space of 6 inches (150 mm) between strips, over built-up roofing. Adhere in hot roofing asphalt.
  3. Roof-Paver Walkways: Install walkway roof pavers according to roofing manufacturer's written instructions in locations indicated, to form walkways. Leave 3 inches (75 mm) of space between adjacent roof pavers.
- K. Field Quality Control
1. Testing Agency: Perform roof tests and inspections and to prepare test reports.
  2. Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of built-up roofing as follows:
    - a. Approximate quantities of components within built-up roofing will be determined according to ASTM D 3617.
    - b. Test specimens will be examined for interply voids according to ASTM D 3617 and to comply with criteria established in Appendix 3 of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
    - c. Repair areas where test cuts were made according to roofing manufacturer's written instructions.
  3. Repair or remove and replace components of built-up roofing where test results or inspections indicate that they do not comply with specified requirements.
    - a. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- L. Protecting And Cleaning
1. Protect built-up roofing from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and the Owner.
  2. Correct deficiencies in or remove built-up roofing that does not comply with requirements, repair substrates, and repair or reinstall roofing to a condition free of damage and deterioration at time of Final Completion and according to warranty requirements.
  3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 65 16 00



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**SECTION 07 65 16 00a - BUILT-UP COAL-TAR ROOFING**

## 1.1 GENERAL

## A. Description Of Work:

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

## B. Summary

1. Section Includes:
  - a. Built-up coal-tar roofing.
  - b. Vapor retarder.
  - c. Roof insulation.
2. Section includes the installation of insulation strips in ribs of acoustical roof deck. Insulation strips are furnished under Division 05 Section "Steel Decking".

## C. Definitions

1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to built-up roofing.
2. Bitumen: A generic term for either asphalt or coal-tar pitch.
3. Hot Coal-Tar Pitch: Coal-tar pitch heated to its equiviscous temperature, the temperature at which its viscosity is 25 centipoise for either mopping or mechanical application, within a range of plus or minus 25 deg F (14 deg C), measured at the mop cart or mechanical spreader immediately before application.
4. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mop-applied roofing asphalt and 75 centipoise for mechanical spreader-applied roofing asphalt, within a range of plus or minus 25 deg F (14 deg C), measured at the mop cart or mechanical spreader immediately before application.

## D. Performance Requirements

1. General Performance: Installed built-up roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Built-up roofing and base flashings shall remain watertight.
2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by built-up roofing manufacturer based on testing and field experience.
3. Roofing System Design (if built-up roofing system is to be designed to withstand uplift pressure established by ASCE/SEI 7): Provide built-up roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
  - a. Corner Uplift Pressure: as directed by the Owner.
  - b. Perimeter Uplift Pressure: as directed by the Owner.
  - c. Field-of-Roof Uplift Pressure: as directed by the Owner.
4. FM Approvals Listing (if Project is FM Global insured or if FM Approvals requirements will set a minimum quality standard): Provide built-up roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a built-up roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
  - a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120, **as directed**.
  - b. Hail Resistance Rating: MH **OR** SH, **as directed**.



5. Energy Performance (if required for LEED-NC Credit SS 7.2): Provide roofing system with initial Solar Reflectance Index not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.
6. Energy Performance (for roofs that must comply with the DOE's ENERGY STAR requirements): Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
7. Energy Performance (for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

#### E. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
  - a. Product Test Reports for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
  - b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For built-up roofing. Include plans, elevations, sections, details, and attachments to other work.
  - a. Base flashings and built-up terminations.
  - b. Tapered insulation, including slopes.
  - c. Crickets, saddles, and tapered edge strips, including slopes.
  - d. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
4. Samples: For the following products:
  - a. Built-up roofing materials, including base sheet, ply sheet and flashing sheet, of color specified.
  - b. Roof insulation.
  - c. 3 lb (1.5 kg) of aggregate surfacing material in gradation and color indicated.
  - d. Walkway pads.
  - e. Six insulation fasteners of each type, length, and finish.
5. Qualification Data: For qualified Installer and manufacturer.
6. Manufacturer Certificates: Signed by roofing manufacturer certifying that built-up roofing complies with requirements specified in "Performance Requirements" Article.
  - a. Submit evidence of compliance with performance requirements.
7. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of built-up roofing.
8. Research/Evaluation Reports: For components of built-up roofing, from the ICC-ES **OR** other applicable model code organization, **as directed**.
9. Maintenance Data: For built-up roofing to include in maintenance manuals.
10. Warranties: Sample of special warranties.

#### F. Quality Assurance

1. Manufacturer Qualifications: A qualified manufacturer that is UL listed **OR** FM Approvals approved, **as directed**, for built-up roofing identical to that used for this Project.
2. Installer Qualifications (if Project is FM Global insured and if a certified roofing installer is required): A qualified firm that is approved, authorized, or licensed by built-up roofing manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
3. Source Limitations (if required to comply with FM Approvals, UL, or another building code, or to comply with provisions of manufacturer's special warranty): Obtain components including roof insulation and fasteners for built-up roofing from same manufacturer as built-up roofing or approved by built-up roofing manufacturer.
4. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical built-up roofing materials



- by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
5. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  6. Preinstallation Roofing Conference: Conduct conference at Project site.
- G. Delivery, Storage, And Handling
1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
  2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing manufacturer. Protect stored liquid material from direct sunlight.
    - a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
  3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
  4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.
- H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be installed according to manufacturer's written instructions and warranty requirements.
- I. Warranty
1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of built-up roofing that fail in materials or workmanship within specified warranty period.
    - a. Special warranty includes built-up roofing membrane, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, roof pavers, and other components of built-up roofing.
    - b. Warranty Period: 10 **OR** 15 **OR** 20 **OR** 25 **OR** 30, **as directed**, years from date of Final Completion.
- 1.2 PRODUCTS
- A. Base-Sheet Materials
1. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).
  2. Base Sheet: ASTM D 4601, Type I **OR** II, **as directed**, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.  
**OR**  
Base Sheet: ASTM D 4897, Type II, venting, nonperforated, heavyweight, asphalt-impregnated and -coated, glass-fiber base sheet with coarse granular surfacing or embossed venting channels on bottom surface.  
**OR**  
Base Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.
- B. Roofing Membrane Plies
1. Ply Sheet: ASTM D 227, coal-tar-saturated organic felt.  
**OR**



Ply Sheet: ASTM D 4990, Type I, coal-tar-impregnated, glass-fiber felt and the physical properties of ASTM D 2178, Type IV **OR** VI, **as directed**.

C. Base Flashing Sheet Materials

1. Backer Sheet: ASTM D 2178, Type IV, asphalt-impregnated, glass-fiber felt.  
**OR**  
Backer Sheet: Roofing manufacturer's standard spun-bonded, nonwoven, polyester-reinforced fabric, of standard color and weight, suitable for application method specified.
2. Granule-Surfaced Flashing Sheet: ASTM D 6164, Grade G, Type I or II, polyester-reinforced, SBS-modified asphalt sheet; granular surfaced base flashing; suitable for application method specified, and as follows:
  - a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
3. Polyester Flashing Sheet: Roofing manufacturer's standard asphalt-coated, polyester-reinforced fabric, base flashing, suitable for application method specified.
4. Fabric Termination: Roofing manufacturer's standard polyester cloth, suitable for application and for reinforcing top seal of base flashing.

D. Bitumen Materials

1. Asphalt Primer: ASTM D 41.  
**OR**  
Coal-Tar Primer: ASTM D 43.
2. Coal-Tar Pitch: ASTM D 450, Type I.
3. Roofing Asphalt: ASTM D 312, Type III **OR** IV **OR** III or IV as recommended by built-up roofing manufacturer for application, **as directed**.  
**OR**  
Roofing Asphalt: ASTM D 6152, SEBS modified.

E. Auxiliary Built-Up Roofing Materials

1. General: Auxiliary materials recommended by built-up roofing manufacturer for intended use and compatible with built-up roofing.
  - a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
  - b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    - 1) Plastic Foam Adhesives: 50 g/L.
    - 2) Gypsum Board and Panel Adhesives: 50 g/L.
    - 3) Multipurpose Construction Adhesives: 70 g/L.
    - 4) Fiberglass Adhesives: 80 g/L.
    - 5) Contact Adhesives: 80 g/L.
    - 6) Other Adhesives: 250 g/L.
    - 7) Nonmembrane Roof Sealants: 300 g/L.
    - 8) Sealant Primers for Nonporous Substrates: 250 g/L.
    - 9) Sealant Primers for Porous Substrates: 775 g/L.
2. Cold-Applied Adhesive: Roofing manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with built-up base flashings.
3. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing manufacturer for application.
4. SBS-Modified Asphalt Flashing Cement: Roofing manufacturer's standard, asbestos free, of consistency required for application.
5. Coal-Tar Roofing Cement: ASTM D 5643, coal-tar-based roofing cement, asbestos free.
6. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening built-up roofing components



- to substrate, tested by manufacturer for required pullout strength, and acceptable to roofing manufacturer.
7. Metal Flashing Sheet: Metal flashing sheet is specified in Division 07 Section "Sheet Metal Flashing And Trim".
  8. Metal Termination Bars: Roofing manufacturer's standard predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
  9. Roof Coatings: ASTM D 2824, Type I, nonfibered **OR** III, fibered, asbestos-free, **as directed**, aluminum-pigmented asphaltic coating.  
**OR**  
Roof Coatings: ASTM D 6083, acrylic elastomer emulsion coating, formulated for use on bituminous roof surfaces.
    - a. Color: White **OR** Gray **OR** Buff, **as directed**.
  10. Aggregate Surfacing: ASTM D 1863, No. 6 or No. 67, clean, dry, opaque, water-worn gravel or crushed stone, free of sharp edges **OR** crushed slag, free of sharp edges, **as directed**.
  11. Walkway Pads: Mineral-granule-surfaced, reinforced asphaltic composition **OR** Polymer-modified, reconstituted solid-rubber, surface-textured, **as directed**, slip-resisting pads, manufactured as a traffic pad for foot traffic and acceptable to built-up roofing manufacturer, 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, thick, minimum.
  12. Miscellaneous Accessories: Provide miscellaneous accessories recommended by built-up roofing manufacturer.
- F. Substrate Boards
1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.  
**OR**  
Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.  
**OR**  
Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.  
**OR**  
Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.
  2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.
- G. Vapor Retarder
1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
    - a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.  
**OR**  
Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
  2. Laminated Sheet: Kraft paper/polyethylene laminate, two layers, reinforced with woven fiberglass yarn, laminated and edge reinforced, with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
  3. Self-Adhering Sheet Vapor Retarder: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, polyethylene film laminated to layer of rubberized asphalt adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold-applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.  
**OR**  
Self-Adhering Sheet Vapor Retarder: 30- to 40-mil- (0.76- to 1.0-mm-) thick, polyethylene film laminated to layer of butyl rubber adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s



x sq. m); cold-applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

4. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt impregnated.

#### H. Roof Insulation

1. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
3. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other surface.
  - a. Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick.
  - b. Type V, OSB facer, 7/16 inch (11 mm) thick.
  - c. Type VII, glass mat faced gypsum board facer, 1/4 inch (6 mm) thick.
4. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
5. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 1, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
6. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
7. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/8 inch per 12 inches (1:96) **OR** 1/4 inch per 12 inches (1:48), **as directed**, unless otherwise indicated.
8. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

#### I. Insulation Accessories

1. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with built-up roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate and acceptable to roofing manufacturer.
3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphaltic, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
4. Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
5. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
6. Insulation Cant Strips: ASTM C 728, perlite insulation board.  
**OR**  
Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
7. Wood Nailer Strips: Comply with requirements in Division 6 Section "Rough Carpentry" **OR** "Miscellaneous Carpentry", **as directed**.
8. Tapered Edge Strips: ASTM C 728, perlite insulation board.  
**OR**  
Tapered Edge Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
9. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.  
**OR**



Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.

**OR**

Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.

**OR**

Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.

10. Substrate Joint Tape: 6- or 8-inch- (150- or 200-mm-) wide, coated, glass fiber.

### 1.3 EXECUTION

#### A. Examination

1. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
  - a. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
  - b. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
  - c. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 5 Section "Steel Deck."
  - d. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch (1.6 mm) out of plane relative to adjoining deck.
  - e. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
  - f. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
    - 1) Test for moisture by pouring 1 pint (0.5 L) of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if test sample foams or can be easily and cleanly stripped after cooling.
  - g. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### B. Preparation

1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Prime surface of concrete deck with asphalt **OR** coal-tar, **as directed**, primer at a rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
4. Install insulation strips in ribs of acoustical roof decks according to acoustical roof deck manufacturer's written instructions.

#### C. Substrate Board Installation

1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
  - a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.

**OR**

Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to built-up roofing manufacturers' written instructions.



#### D. Vapor-Retarder Installation

1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
  - a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.
2. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:
  - a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.  
**OR**  
Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.
3. Self-Adhering Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches (90 mm) and 6 inches (150 mm), respectively. Seal laps by rolling.
4. Built-up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
5. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into built-up roofing system.

#### E. Insulation Installation

1. Comply with built-up roofing manufacturer's written instructions for installing roof insulation.
2. Install one lapped base sheet course and mechanically fasten to substrate according to built-up roofing manufacturer's written instructions.
3. Nailer Strips: Mechanically fasten 4-inch nominal- (89-mm actual-) width wood nailer strips of same thickness as insulation perpendicular to sloped roof deck, spaced 16 feet (4.88 m) apart for roof slopes greater than 1/4 inch per 12 inches (1:48) **OR** 1/2 inch per 12 inches (1:24), **as directed**.
4. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of built-up roofing with vertical surfaces or angle changes greater than 45 degrees.
5. Install tapered insulation under area of roofing to conform to slopes indicated.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
  - a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
  - a. Where installing composite and noncomposite board insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
8. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
9. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
10. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
  - a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
  - b. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.  
**OR**



- Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
- OR**
- Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
11. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
- a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
- b. If number of fasteners will be based on ASCE/SEI 7's uplift pressure, fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
12. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
- a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
- b. If fastening is calculated from ASCE/SEI 7's uplift pressure, fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
- c. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
- OR**
- Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
- OR**
- Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
13. If cover boards will be field installed over roof insulation and immediately below built-up roofing, install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck, **as directed**. Tape joints if required by roofing manufacturer.
- a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
- OR**
- Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.
- b. Apply hot roofing asphalt to underside and immediately bond cover board to substrate.
- F. Built-Up Roofing Installation, General
1. If referencing NRCA's roof assembly identification matrix system, install roofing membrane according to roofing manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
- a. Install roofing system BU-3 **OR** 4 **OR** 5, **as directed**, -N **OR** I **OR** C, **as directed**, -A-A, according to roof assembly identification matrix and roof assembly layout illustrations in NRCA's "The NRCA Roofing and Waterproofing Manual" and requirements in this Section.
2. For roofing that exceeds requirements of NRCA's roof assemblies, install built-up roofing membrane according to roofing manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing" and as follows:
- a. Deck Type: N (nailable) **OR** I (insulated) **OR** C (concrete or nonnailable), **as directed**.
- b. Base Sheet: 1 **OR** 1, installed over sheathing paper, **as directed**.
- c. Number of Organic Felt Ply Sheets: 2 **OR** 3 **OR** 4, **as directed**.
- d. Number of Glass Fiber Ply Sheets: 1, top ply **OR** 2 **OR** 3 **OR** 4, **as directed**.
- e. Surfacing Type: A (aggregate).



3. Start installation of built-up roofing in presence of manufacturer's technical personnel.
  4. Where roof slope exceeds 1/4 inch per 12 inches (1:48) **OR** 1/2 inch per 12 inches (1:24), **as directed**, install built-up roofing sheets parallel with slope.
    - a. Backnail built-up roofing sheets to nailer strips **OR** substrate, **as directed**, according to roofing manufacturer's written instructions.
  5. Cooperate with testing agencies engaged or required to perform services for installing roofing system.
  6. Coordinate installation of built-up roofing so insulation and other components of built-up roofing not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
    - a. Provide tie-offs at end of each day's work to cover exposed built-up roofing sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.
    - b. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
    - c. Remove and discard temporary seals before beginning work on adjoining roofing.
  7. Bitumen Heating: Do not raise bitumen temperature above equiviscous temperature range more than one hour before time of application. Do not exceed bitumen manufacturer's recommended temperature limits during bitumen heating. Do not heat bitumen within 25 deg F (14 deg C) of flash point. Discard bitumen maintained for more than 4 hours at a temperature exceeding 325 deg F (163 deg C) for coal-tar pitch or finished blowing temperature for roofing asphalt, **as directed**.
    - a. Mopping Weights: For interply and other moppings, unless otherwise indicated, apply solid moppings of hot coal-tar pitch between ply sheets at a minimum rate of 20 lb/100 sq. ft. (1 kg/sq. m).
  8. SEBS-Asphalt Heating: Heat and apply SEBS-modified roofing asphalt according to roofing manufacturer's written instructions.
  9. Substrate-Joint Penetrations: Prevent bitumen and adhesives from penetrating substrate joints, entering building, or damaging built-up roofing components or adjacent building construction.
- G. Roofing Membrane Installation
1. If sheathing paper is required over wood decks by built-up roofing manufacturer, loosely lay one course of sheathing paper, lapping edges and ends a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
  2. Install lapped base sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:
    - a. Mechanically fasten to substrate, for nailable substrate.  
**OR**  
Spot- or strip-mop to substrate with hot roofing asphalt.  
**OR**  
Adhere to substrate in a solid mopping of hot roofing asphalt **OR** uniform coating of cold-applied adhesive, **as directed**, for nonnailable or insulated substrates.
  3. Monolithic Membrane: Install two **OR** three **OR** four, **as directed**, ply sheets starting at low point of roofing system. Align ply sheets without stretching. Shingle side laps of ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane. Shingle in direction to shed water. Extend ply sheets over and terminate beyond cants. Embed each ply sheet in a solid mopping of hot coal-tar pitch to form a uniform membrane without ply sheets touching.  
**OR**  
Composite Membrane: Install two **OR** three **OR** four, **as directed**, organic felt ply sheets starting at low point of roofing system. Align organic felt ply sheets without stretching. Shingle side laps of organic felt ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane. Shingle in direction to shed water.
    - a. Install finish layer of one lapped coal-tar, glass-fiber ply sheet course over shingled organic felt ply sheets, starting at low point of built-up roofing. Offset laps from laps of preceding



- ply sheets and align coal-tar, glass-fiber ply sheet without stretching. Lap in direction to shed water.
- b. Extend ply sheets over and terminate beyond cants.
  - c. Embed each ply sheet in a solid mopping of hot coal-tar pitch applied at rate required by built-up roofing manufacturer, to form a uniform membrane without ply sheets touching.
4. If delayed flood coating and aggregate surfacing of coal-tar, glass-fiber membrane or finish layer are permitted, glaze-coat roofing membrane surface with hot coal-tar pitch applied at a rate of 10 to 15 lb/100 sq. ft. (0.5 to 0.75 kg/sq. m) if aggregate surfacing is not applied immediately.
  5. Aggregate Surfacing: If surfacing roofing membrane with aggregate, promptly after installing and testing roofing membrane, base flashing, and stripping, flood-coat roof surface with 70 lb/100 sq. ft. (3.5 kg/sq. m) of hot coal-tar pitch. While flood coat is hot and fluid, cast the following average weight of aggregate in a uniform course:
    - a. Aggregate Weight: 400 lb/100 sq. ft. (20 kg/sq. m) for gravel or crushed stone or 300 lb/100 sq. ft. (15 kg/sq. m) for slag.
    - b. Sweep loose aggregate from roof surface and apply another flood coat of not less than 85 lb/100 sq. ft. (4.15 kg/sq. m) of hot coal-tar pitch. While flood coat is hot and fluid, apply a uniform course of aggregate at the following rate. Sweep away loose aggregate and fully embed aggregate by lightly rolling into finished roof surface.
      - 1) Aggregate Weight: 300 lb/100 sq. ft. (15 kg/sq. m) for gravel or crushed stone 200 lb/100 sq. ft. (10 kg/sq. m) for slag, average.
  6. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size according to walkway pad manufacturer's written instructions.
    - a. Sweep away loose aggregate surfacing and set walkway pads in additional flood coat of hot coal-tar pitch.

#### H. Flashing And Stripping Installation

1. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to built-up roofing manufacturer's written instructions and as follows:
  - a. Prime substrates with asphalt primer if required by built-up roofing manufacturer.
  - b. Backer Sheet Application: Install single backer sheet and adhere to substrate in a solid mopping of hot roofing asphalt **OR** asphalt roofing cement **OR** SBS-modified asphalt roofing cement **OR** cold-applied adhesive, **as directed**.  
**OR**  
Backer Sheet Application: Install two **OR** three, **as directed**, backer sheets and adhere to substrate in a solid mopping of hot roofing asphalt **OR** asphalt roofing cement, **as directed**.
  - c. Flashing Sheet Application: Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C). Apply hot roofing asphalt to back of flashing sheet if recommended by roofing manufacturer.  
**OR**  
Flashing Sheet Application: Adhere flashing sheet to substrate in SBS-modified asphalt roofing cement **OR** asphalt roofing cement, **as directed**.
2. Extend base flashing up walls or parapets a minimum of 8 inches (200 mm) above built-up roofing and 4 inches (100 mm) onto field of built-up roofing.
3. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.
  - a. Securely fasten top termination of base flashing with continuous metal termination bar anchored into substrate.
  - b. Seal top termination of base flashing with a strip of glass-fiber fabric set in asphalt roofing cement, **as directed**.
4. Apply roof coatings to smooth base flashings according to manufacturer's written instructions, by spray, roller, or other suitable application method.
5. Install stripping, according to roofing system manufacturer's written instructions, where metal flanges and edgings are set on built-up roofing.
  - a. Flashing-Sheet Stripping: Install flashing-sheet stripping in a cold-applied adhesive or in a solid mopping of hot coal-tar pitch and extend onto roofing membrane.

**OR**

Built-up Stripping: Install stripping of not less than two roofing membrane ply sheets, setting each ply in a continuous coal-tar roofing cement or in a solid mopping of hot coal-tar pitch, and extend onto roofing membrane 4 inches (100 mm) and 6 inches (150 mm), respectively.

6. Roof Drains: Set 30-by-30-inch (760-by-760-mm) metal flashing in bed of asphalt roofing cement on completed built-up roofing. Cover metal flashing with built-up roofing cap-sheet stripping and extend a minimum of 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, beyond edge of metal flashing onto field of built-up roofing. Clamp built-up roofing, metal flashing, and stripping into roof-drain clamping ring.

- a. Flashing-Sheet Stripping: Install flashing-sheet stripping in cold-applied adhesive or in a solid mopping of hot coal-tar pitch and extend onto roofing membrane.

**OR**

Built-up Stripping: Install stripping of not less than 2 roofing membrane ply sheets, setting each ply in a continuous coating of coal-tar roofing cement or in a solid mopping of hot coal-tar pitch, and extend onto roofing membrane 4 inches (100 mm) and 6 inches (150 mm), respectively.

## I. Field Quality Control

1. Testing Agency: Perform roof tests and inspections, observe flood tests, and prepare test reports.
2. Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of built-up roofing as follows:
  - a. Approximate quantities of components within built-up roofing will be determined according to ASTM D 3617.
  - b. Test specimens will be examined for interply voids according to ASTM D 3617 and to comply with criteria established in Appendix 3 of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
  - c. Repair areas where test cuts were made according to built-up roofing manufacturer's written instructions.
3. Flood Testing: Flood test each roofing membrane area for leaks, according to recommendations in ASTM D 5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
  - a. Flood to an average depth of 2-1/2 inches (65 mm) with a minimum depth of 1 inch (25 mm) and not exceeding a depth of 4 inches (100 mm). Maintain 2 inches (50 mm) of clearance from top of base flashing.
  - b. Flood each area for 24 **OR** 48 **OR** 72, **as directed**, hours.
  - c. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.
4. Repair or remove and replace components of roofing system where test results or inspections indicate that they do not comply with specified requirements.
  - a. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

## J. Protecting And Cleaning

1. Protect built-up roofing from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to the Owner.
2. Correct deficiencies in or remove built-up roofing that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Final Completion and according to warranty requirements.
3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.



END OF SECTION 07 65 16 00a



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**SECTION 07 65 16 00b - EPDM MEMBRANE ROOFING**

## 1.1 GENERAL

## A. Description Of Work:

1. This specification covers the furnishing and installation of materials for ethylene-propylene-diene-monomer (EPDM) roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

## B. Summary

1. Section Includes:
  - a. Adhered EPDM membrane roofing system.
  - b. Mechanically fastened EPDM membrane roofing system.
  - c. Loosely laid and ballasted EPDM membrane roofing system.
  - d. Vapor retarder.
  - e. Roof insulation.
2. Section includes the installation of acoustical roof deck rib insulation strips furnished under Division 05 Section "Steel Decking".

## C. Definitions

1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

## D. Performance Requirements

1. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
3. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
4. FM Approvals Listing: Provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals' markings.
  - a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120 **OR** Class 1A-135 **OR** Class 1A-150 **OR** Class 1A-165, **as directed**.
  - b. Hail Resistance: MH **OR** SH, **as directed**.
5. Energy Performance (for "cool-roof" performance): Provide roofing system with initial Solar Reflectance Index not less than 78 **OR** 29, **as directed**, when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency, **as directed**.
6. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low **OR** steep, **as directed**, -slope roof products, **as directed**.
7. Energy Performance: Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

## E. Submittals

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



- a. Product Test Reports for Credit SS 7.2: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirement.
  - b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
  3. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
  4. Samples: For each product included in the roofing system.
  5. Manufacturer Certificate: Signed by roofing manufacturer certifying that membrane roofing system complies with requirements specified in "Performance Requirements" Article.
    - a. Submit evidence of complying with performance requirements.
  6. Research/evaluation reports.
  7. Field quality-control reports.
  8. Maintenance data.
  9. Warranties: Sample of special warranties.
- F. Quality Assurance
1. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
  2. Source Limitations: Obtain components for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.
  3. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
  4. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  5. Preinstallation Roofing Conference: Conduct conference at Project site.
- G. Delivery, Storage, And Handling
1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
  2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
    - a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
  3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
  4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.
- H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.
- I. Warranty
1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within 10 **OR** 15 **OR** 20, **as directed**, years from date of Final Completion.



## 1.2 PRODUCTS

### A. EPDM Membrane Roofing

1. EPDM: ASTM D 4637, Type I, non-reinforced, **OR** Type II, scrim or fabric internally reinforced, **as directed**, uniform, flexible EPDM sheet.
  - a. Thickness: 45 mils (1.1 mm) **OR** 60 mils (1.5 mm) **OR** 75 mils (1.9 mm) **OR** 90 mils (2.2 mm), **as directed**, nominal.
  - b. Exposed Face Color: Black **OR** White on black, **as directed**.
2. Fabric-Backed EPDM: ASTM D 4637, Type III, non-reinforced, uniform, flexible EPDM sheet, laminated to a nonwoven polyester fabric backing except at selvages.
  - a. Composite Thickness: 90 mils (2.3 mm) **OR** 100 mils (2.5 mm) **OR** 105 mils (2.7 mm) **OR** 115 mils (2.9 mm), **as directed**, nominal.
  - b. Exposed Face Color: Black **OR** White on black, **as directed**.

### B. Auxiliary Membrane Roofing Materials

1. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
  - a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
  - b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    - 1) Plastic Foam Adhesives: 50 g/L.
    - 2) Gypsum Board and Panel Adhesives: 50 g/L.
    - 3) Multipurpose Construction Adhesives: 70 g/L.
    - 4) Fiberglass Adhesives: 80 g/L.
    - 5) Contact Adhesive: 80 g/L.
    - 6) Single-Ply Roof Membrane Sealants: 450 g/L.
    - 7) Nonmembrane Roof Sealants: 300 g/L.
    - 8) Sealant Primers for Nonporous Substrates: 250 g/L.
    - 9) Sealant Primers for Porous Substrates: 775 g/L.
    - 10) Other Adhesives and Sealants: 250 g/L.
2. Sheet Flashing: 60-mil- (1.5-mm-) thick EPDM, partially cured or cured, according to application.
3. Protection Sheet: Epichlorohydrin or neoprene non-reinforced flexible sheet, 55- to 60-mil- (1.4- to 1.5-mm-) thick, recommended by EPDM manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease, and oil.
4. Bonding Adhesive: Manufacturer's standard, water based, **as directed**.
5. Modified Asphaltic Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard modified asphalt, asbestos-free, cold-applied adhesive formulated for compatibility and use with fabric-backed membrane roofing.
6. Water-Based, Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard water-based, cold-applied adhesive formulated for compatibility and use with fabric-backed membrane roofing.
7. Low-Rise, Urethane, Fabric-Backed Membrane Adhesive: Roof system manufacturer's standard spray-applied, low-rise, two-component urethane adhesive formulated for compatibility and use with fabric-backed membrane roofing.
8. Seaming Material: Single-component, butyl splicing adhesive and splice cleaner **OR** Manufacturer's standard, synthetic-rubber polymer primer and 3-inch- (75-mm-) wide minimum, butyl splice tape with release film, **as directed**.
9. Lap Sealant: Manufacturer's standard, single-component sealant, colored to match membrane roofing, **as directed**.
10. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.
11. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
12. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick), prepunched.



13. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.
14. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.
15. Liquid coating, specifically formulated for coating EPDM membrane roofing, as follows:
  - a. Type: Acrylic emulsion **OR** Hypalon, **as directed**.
  - b. Color: White **OR** Gray **OR** Tan **OR** As selected from manufacturer's full range, **as directed**.

#### C. Substrate Boards

1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.  
**OR**  
Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick.  
**OR**  
Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.  
**OR**  
Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate panel to roof deck.

#### D. Vapor Retarder

1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
  - a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
  - b. Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
2. Laminated Sheet: Kraft paper, two layers, laminated with asphalt and edge reinforced with woven fiberglass yarn with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt impregnated.

#### E. Roof Insulation

1. General: Preformed roof insulation boards manufactured or approved by EPDM membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) **OR** Type X, 1.3-lb/cu. ft. (21-kg/cu. m), **as directed**, minimum density, square edged.
3. Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density.
4. Composite Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density, with factory-applied facings, as follows:
  - a. Facer: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.  
**OR**  
Facer: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.



5. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
6. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.
  - a. Type IV, cellulosic-fiber-insulation-board facer, Grade 2, 1/2 inch (13 mm) thick.
  - b. Type V, OSB facer, 7/16 inch (11 mm) thick.
  - c. Type VII, glass mat faced gypsum board facer, 1/4 inch (6 mm) thick.
7. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
8. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
9. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
10. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.
11. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

F. Insulation Accessories

1. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards, **as directed**, to substrate, and acceptable to roofing system manufacturer.
3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphalt, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
4. Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
5. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
6. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.  
**OR**  
Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.  
**OR**  
Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.  
**OR**  
Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
7. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

G. Asphalt Materials

1. Roofing Asphalt: ASTM D 312, Type III or Type IV **OR** ASTM D 6152, SEBS modified, **as directed**.
2. Asphalt Primer: ASTM D 41.

H. Aggregate Ballast (for loosely laid and aggregate-ballasted installations)



1. Aggregate Ballast: Provide aggregate ballast that will withstand weather exposure without significant deterioration and will not contribute to membrane degradation, of the following type and size:
  - a. Aggregate Type: Smooth, washed, riverbed gravel or other acceptable smooth-faced stone **OR** Crushed gravel or crushed stone, **as directed**.
  - b. Size: ASTM D 448, Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm).  
**OR**  
Size: ASTM D 448, Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm).  
**OR**  
Size: ASTM D 448, Size 3, ranging in size from 1 to 2 inches (25 to 50 mm).

#### I. Roof Pavers

1. Lightweight Roof Pavers: Interlocking, lightweight concrete units, specially factory cast for use as roof ballast; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:
  - a. Size: 8 by 16 inches (200 by 400 mm) **OR** 12 by 12 inches (300 by 300 mm) **OR** 12 by 16-1/2 inches (300 by 420 mm) **OR** 12 by 18 inches (300 by 450 mm), **as directed**.
  - b. Weight: At least 10 lb/sq. ft. (50 kg/sq. m) but not exceeding 18 lb/sq. ft. (90 kg/sq. m).
  - c. Compressive Strength: 2500 psi (17 MPa) **OR** 5000 psi (34 MPa), **as directed**, minimum.
  - d. Colors and Textures: As selected from manufacturer's full range.
2. Rubber Roof Pavers: Interlocking, lightweight rubber units, 24 by 24 by 2-1/4 inches (600 by 600 by 57 mm), 6 lb/sq. ft. (30 kg/sq. m) specially manufactured for use as roof ballast; with grooved back for four-way drainage, beveled and doweled; and as follows:
  - a. Perimeter Securement Strip: Manufacturer's standard coated steel sheet channel **OR** aluminum sheet channel **OR** mill-finish aluminum sheet hold down **OR** coated aluminum sheet hold down, color as selected, **as directed**, and fasteners.
  - b. Color: Black **OR** Gray **OR** Terra cotta, **as directed**.
3. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
  - a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
  - b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.
  - c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
  - d. Colors and Textures: As selected from manufacturer's full range.

#### J. Walkways

1. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads **OR** rolls, **as directed**, approximately 3/16 inch (5 mm) thick, and acceptable to membrane roofing system manufacturer.
2. Walkway Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
  - a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
  - b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.
  - c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
  - d. Colors and Textures: As selected from manufacturer's full range.



### 1.3 EXECUTION

#### A. Preparation

1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
4. Install acoustical roof deck rib insulation strips, specified in Division 05 Section "Steel Decking", according to acoustical roof deck manufacturer's written instructions, immediately before installation of overlying construction and to remain dry.

#### B. Substrate Board

1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
  - a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.  
**OR**  
Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

#### C. Vapor-Retarder Installation

1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
  - a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.
2. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:
  - a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.  
**OR**  
Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.
3. Built-Up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
4. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

#### D. Insulation Installation

1. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
2. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
3. Install tapered insulation under area of roofing to conform to slopes indicated.
4. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.



- a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
5. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
  - a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
  - a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
  - b. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
  - c. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.  
**OR**  
Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
8. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
  - a. Fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.  
**OR**  
Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
9. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
  - a. Fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.  
**OR**  
Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
  - b. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.  
**OR**  
Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.  
**OR**  
Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
10. Loosely Laid Insulation: Loosely lay insulation units over substrate.
11. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck, **as directed**.
  - a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.  
**OR**  
Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

#### E. Adhered Membrane Roofing Installation

1. Adhere membrane **OR** fabric-backed membrane, **as directed**, roofing over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.



2. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.
5. Hot Roofing Asphalt: Apply a solid mopping of hot roofing asphalt to substrate at temperature and rate required by manufacturer and install fabric-backed membrane roofing. Do not apply to splice area of membrane roofing.  
**OR**  
Fabric-Backed Membrane Adhesive: Apply to substrate at rate required by manufacturer and install fabric-backed membrane roofing.
6. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeters.
7. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
8. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
  - a. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.
9. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
10. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
11. Spread sealant or mastic bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
12. Install membrane roofing and auxiliary materials to tie in to existing membrane roofing to maintain weather-tightness of transition and to not void warranty for existing membrane roofing system.
13. Adhere protection sheet over membrane roofing at locations indicated.

F. Mechanically Fastened Membrane Roofing Installation

1. Mechanically fasten membrane roofing over area to receive roofing according to roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.
  - a. For in-splice attachment, install membrane roofing with long dimension perpendicular to steel roof deck flutes.
2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere membrane roofing securely at terminations, penetrations, and perimeter of roofing.
5. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
6. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
  - a. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.
7. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
8. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.



9. Spread sealant or mastic bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
10. In-Splice Attachment: Secure one edge of membrane roofing using fastening plates or metal battens centered within membrane splice and mechanically fasten membrane roofing to roof deck. Field splice seam.  
**OR**  
Through-Membrane Attachment: Secure membrane roofing using fastening plates or metal battens and mechanically fasten membrane roofing to roof deck. Cover battens and fasteners with a continuous cover strip.
11. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weather-tightness of transition and to not void warranty for existing membrane roofing system.
12. Adhere protection sheet over membrane roofing at locations indicated.

G. Loosely Laid And Ballasted Membrane Roofing Installation

1. Loosely lay membrane roofing over area to receive roofing according to roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.
  - a. Comply with requirements in SPRI RP-4 for System 1 **OR** System 2 **OR** System 3, **as directed**.
2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing, without stretching, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere perimeter of membrane roofing according to requirements in SPRI RP-4.  
**OR**  
Mechanically fasten or adhere membrane roofing at corners, perimeters, and transitions according to requirements in SPRI RP-4.
  - a. At corners and perimeters, omit aggregate ballast leaving membrane roofing exposed.
  - b. At corners and perimeters, adhere a second layer of membrane roofing
5. Apply membrane roofing with side laps shingled with slope of deck where possible.
6. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
  - a. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.
7. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
8. Leave seams uncovered until inspected by membrane roofing system manufacturer **OR** testing agency, **as directed**.
9. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
10. Spread sealant or mastic bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
11. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weather-tightness of transition and to not void warranty for existing membrane roofing system.
12. Adhere protection sheet over membrane roofing at locations indicated.
13. Install protection mat over membrane roofing, overlapping a minimum of 6 inches (150 mm). Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of 12 inches (300 mm).
14. Aggregate Ballast, **as directed**: Apply uniformly over membrane roofing at the rate required by membrane roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of damage to membrane roofing system. Lay ballast as membrane roofing is installed, leaving membrane roofing ballasted at the end of the workday.



- a. Ballast Weight: Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m).  
**OR**  
Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m), at corners and perimeter; Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m), elsewhere.  
**OR**  
Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m).
- 15. Roof-Paver Ballast: Install lightweight **OR** heavyweight, **as directed**, roof-paver ballast according to manufacturer's written instructions.  
**OR**  
Roof-Paver Ballast: Install rubber roof-paver ballast according to manufacturer's written instructions, in locations indicated.
  - a. Install perimeter paver edge securement.  
**OR**  
Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers according to manufacturer's written instructions on roof corners and perimeter.
  - b. Install Size 4 aggregate ballast elsewhere on roofing at a minimum rate of 10 lb/sq. ft. (50 kg/sq. m).  
**OR**  
Install Size 2 aggregate ballast elsewhere on roofing at a minimum rate of 13 lb/sq. ft. (65 kg/sq. m).
- H. Base Flashing Installation
  - 1. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
  - 2. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
  - 3. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
  - 4. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
  - 5. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars, **as directed**.
- I. Coating Installation
  - 1. Apply coatings to membrane roofing **OR** base flashings, **as directed**, according to manufacturer's written recommendations, by spray, roller, or other suitable application method.
- J. Walkway Installation
  - 1. Flexible Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.
  - 2. Roof-Paver Walkways: Install walkway roof pavers according to manufacturer's written instructions in locations indicated, to form walkways. Leave 3 inches (75 mm) of space between adjacent roof pavers.
- K. Field Quality Control
  - 1. Testing Agency: Engage a qualified independent testing agency to perform inspections.
  - 2. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
  - 3. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.
  - 4. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- L. Protecting And Cleaning



1. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to the Owner.
2. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Final Completion and according to warranty requirements.
3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 65 16 00b

**SECTION 07 65 16 00c - COATED FOAMED ROOFING**

## 1.1 GENERAL

## A. Description Of Work:

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

## B. Summary

1. Section Includes:
  - a. Spray-applied, polyurethane foam insulation.
  - b. Elastomeric roof coatings.
  - c. Mineral granules.
  - d. Aggregate.
  - e. Walkways.

## C. Performance Requirements

1. Watertightness: Provide coated foamed roofing that is watertight and will not permit the passage of water.
2. Material Compatibility: Provide polyurethane foam, elastomeric coatings, and miscellaneous roofing materials that are compatible with one another and able to bond to substrate under conditions of service and application required, as demonstrated by coated foamed roofing manufacturer based on testing and field experience.
3. Roofing System Design: Provide a coated foamed roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to SEI/ASCE 7.
4. FMG Listing: Provide roofing system and component materials that comply with requirements in FMG 4450 for steel roof decks and FMG 4470 for roof covers as part of a foamed roofing system and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings.
  - a. Fire/Windstorm Classification: Class 1A-60 **OR 75 OR 90 OR 105 OR 120, as directed.**
  - b. Hail-Resistance Classification: MH **OR SH, as directed.**
5. Energy Performance: Provide roofing system with Solar Reflectance Index not less than 78 **OR 29, as directed**, when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.

## D. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittal:
  - a. Product Test Reports for Credit SS 7.2: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirement.
3. Samples: For each exposed product and for each color and texture specified.
4. Research/evaluation reports.
5. Maintenance data.
6. Warranty: Sample of special warranty.
7. Warranty: Sample of special warranty.

## E. Quality Assurance

1. Installer Qualifications: A qualified installer who is approved, authorized, or licensed by roof coating manufacturer for installation of manufacturer's product over polyurethane foam.



- a. Engage an installer who participates in and who has fulfilled requirements of the SPFA Accreditation Program for company accreditation and individual applicator accreditation for personnel assigned to work on Project.
2. Source Limitations: Obtain polyurethane foam materials from single source or producer and coating products from single, coated foamed roofing manufacturer.
3. Fire-Test-Response Characteristics: Provide coated foamed roofing systems with the fire-test-response characteristics indicated, as determined by testing identical systems per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
  - a. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes of 75 and 450, respectively; ASTM E 84.
  - b. Exterior Fire-Test Exposure: ASTM E 108; Class A.
  - c. Fire-Resistance Ratings: ASTM E 119, determined for coated polyurethane foam roofing as part of a roof assembly.
4. Comply with recommendations in NRCA's "Quality Control Guidelines for the Application of Spray Polyurethane Foam Roofing."
5. Comply with recommendations in SPFA AY 104, "Spray Polyurethane Foam Systems for New and Remedial Roofing."
6. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling

1. Deliver materials to Project site in original containers with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, shelf life, and directions for storing and mixing with other components.
2. Store materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by manufacturer. Protect stored materials from direct sunlight.
3. Remove and replace material that cannot be applied within its stated shelf life.

G. Warranty

1. Special Warranty: Coated foamed roofing manufacturer's standard form in which manufacturer agrees to repair or replace coated foamed roofing that does not comply with requirements or that does not remain watertight within five **OR 10, as directed**, years from date of Final Completion.

## 1.2 PRODUCTS

A. Polyurethane Foam

1. Polyurethane Foam: Rigid cellular polyurethane, spray applied, produced by the catalyzed chemical reaction of polyisocyanates with polyhydroxyls, with stabilizers, fire retardants, and blowing agents added; and complying with ASTM C 1029, Type III, as certified by a qualified independent testing agency.
  - a. In-Place Density: 2.8 to 3.0 lb/cu. ft. (44.9 to 48.1 kg/cu. m); ASTM D 1622.
  - b. Surface-Burning Characteristic: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
    - 1) Flame-Spread Index: 75 or less.

B. Urethane Coatings

1. Urethane Coatings: Liquid urethane elastomeric coating system, specifically formulated for coating spray polyurethane roofing, of the following composition, coat type, and topcoat color and complying with specified performance and physical requirements.
  - a. Base-Coat Composition and Type: One-component **OR** Two-component, **as directed**, aromatic urethane.



- b. Topcoat Composition and Type: One-component **OR** Two-component, **as directed**, aromatic **OR** aliphatic, **as directed**, urethane.
  - c. Topcoat Color: White **OR** Gray **OR** Tan **OR** Copper **OR** Black, **as directed**.
  - d. Topcoat Color at Walkways: White **OR** Gray **OR** Tan **OR** Copper **OR** Black, **as directed**.
  - e. Tensile Strength: 400 psi (2.8 MPa) per ASTM D 412.
  - f. Elongation: 300 percent at 75 deg F (24 deg C) per ASTM D 412.
  - g. Permanent Set at Break: 30 percent maximum per ASTM D 412.
  - h. Tear Resistance: 100 lbf/inch (17.5 kN/m) per ASTM D 1004.
  - i. Water Absorption: 3 percent maximum by weight, 168 hours at 75 deg F (24 deg C) per ASTM D 471.
  - j. Permeance:
    - 1) Minimum 0.7 perms (40.2 ng/Pa x s x sq. m) at 20 mils (0.5 mm) thick per ASTM E 96.  
**OR**  
Minimum 5.0 perms (286 ng/Pa x s x sq. m) at 20 mils (0.5 mm) thick per ASTM E 96.
- C. Silicone Coatings
- 1. Silicone Coatings: Liquid silicone elastomeric coating system, complying with ASTM D 6694 and specifically formulated for coating spray polyurethane roofing.
    - a. Base-Coat and Topcoat Composition: One-component **OR** Two-component, **as directed**, silicone.
    - b. Topcoat Color: White **OR** Gray, **as directed**.
    - c. Topcoat Color at Walkways: White **OR** Gray, **as directed**.
    - d. Permeance: Minimum 5.0 perms (286 ng/Pa x s x sq. m) at 20 mils (0.5 mm) thick per ASTM E 96.
- D. Acrylic Coatings
- 1. Acrylic Coatings: Liquid acrylic elastomeric emulsion coating system, complying with ASTM D 6083 and specifically formulated for coating spray polyurethane roofing.
    - a. Topcoat Color: White **OR** Gray **OR** Buff, **as directed**.
    - b. Topcoat Color at Walkways: White **OR** Gray **OR** Buff, **as directed**.
    - c. Permeance: Minimum 5.0 perms (286 ng/Pa x s x sq. m) at 20 mils (0.5 mm) thick per ASTM E 96.
- E. Substrate Board
- 1. Thermal Barrier:
    - a. Glass-mat, water-resistant gypsum board, ASTM C 1177/C 1177M, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), Type X, **as directed**.
    - b. ASTM C 36/C 36M, 5/8-inch (16-mm) gypsum board base, Type X.
  - 2. Recovery Board and Fasteners: As recommended by polyurethane foam manufacturer, and meeting the requirements of Division 07 Section "Preparation For Re-roofing".
  - 3. Thermal-Barrier Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FMG 4470, and designed and sized for fastening thermal barrier to substrate.
- F. Auxiliary Materials
- 1. Primer: Polyurethane foam manufacturer's standard factory-formulated primer.
  - 2. Vapor Retarder: Fluid applied **OR** Bituminous membrane **OR** As recommended by coated foamed roofing manufacturer, **as directed**.
  - 3. Mineral Granules: Ceramic-coated roofing granules, No. 11 screen size with 100 percent passing No. 8 (2.36-mm) sieve and 98 percent of mass retained by No. 40 (0.42-mm) sieve.
    - a. Color: Buff white **OR** Gray **OR** Green **OR** Red, **as directed**.
  - 4. Aggregate: Coarse mineral aggregate, 3/4 inch (19 mm) maximum, ASTM D 1863, No. 7 or No. 67 gradation.



5. Reinforcement: Flexible polyester or fiberglass mat of weight, type, and composition recommended by roof coating manufacturer for embedment in liquid coating.
6. Walkway Pads: Factory formed of nonwoven PVC strands, porous, UV stabilized, of 5/16-inch (8-mm) nominal thickness, and approved by roof coating manufacturer. Provide pad sizes indicated.
  - a. Color: Yellow **OR** Gray **OR** Blue **OR** Orange **OR** Green, **as directed**.
7. Sealant: ASTM C 920, Class 25, Use NT, Grade NS, Type M, multicomponent urethane **OR** Type S, one-component, neutral- or acid-curing silicone, **as directed**, and as recommended by coated foamed roofing manufacturer for substrate and joint conditions and for compatibility with roofing materials.
8. Sheet Flashing and Accessories: Types recommended by coated foamed roofing manufacturer, provided at locations indicated and as recommended by coated foamed roofing manufacturer.

### 1.3 EXECUTION

#### A. Substrate Board

1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
  - a. Fasten thermal barrier to top flanges of steel deck according to recommendations in FMG's "Approval Guide" for specified Windstorm Resistance Classification.
  - b. Fasten thermal barrier to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to coated foamed roofing manufacturer's written instructions.
  - c. Install recovery board according to coated foamed roofing manufacturer's written instructions and the requirements of Division 07 Section "Preparation For Re-roofing". Fasten through existing roofing to roof structure as indicated. Space fasteners for wind-uplift conditions at Project site **OR** as indicated, **as directed**.

#### B. Surface Preparation

1. Clean and prepare substrate according to coated foamed roofing manufacturer's written instructions. Provide clean, dust-free, dew-free, and dry substrate for coated foamed roofing application.
2. Remove grease, oil, form-release agents, curing compounds, and other contaminants from substrate.
3. Prepare substrate for recovering according to Division 07 Section "Preparation For Re-roofing" and to coated foamed roofing manufacturer's written instructions.
4. Cover and mask adjoining surfaces not receiving coated foamed roofing to prevent overspray or spillage affecting other construction. Close off roof drains, removing roof-drain plugs when no work is being done or when rain is forecast.
  - a. Remove masking after polyurethane foam application and remask adjoining substrates before coating.
5. Prime substrate if recommended by coated foamed roofing manufacturer.
6. Fill, cover, or tape joints and cracks in substrate that exceed a width of 1/4 inch (6 mm). Remove dust and dirt from joints and cracks before applying polyurethane foam.
7. Install vapor retarder according to coated foamed roofing manufacturer's written instructions.

#### C. Polyurethane Foam Application

1. General: Mix and apply polyurethane foam according to ASTM D 5469 and coated foamed roofing manufacturer's written instructions.
  - a. Fill irregularities and areas of ponding.
  - b. Apply the required full thickness of polyurethane foam in any specific area on same day.
  - c. Apply only the area of polyurethane foam that can be covered on same day with required base coating.
  - d. Apply polyurethane foam to avoid overspray beyond immediate area of work.



2. Apply polyurethane foam in lift thicknesses not less than 1/2 inch (13 mm) and not more than 1-1/2 inches (38 mm).
3. Uniformly apply total thickness of polyurethane foam indicated, but not less than 1 inch (25 mm), to a surface tolerance of plus 1/4 inch (6 mm) and no minus.
4. Apply polyurethane foam to roof penetrations, terminations, and vertical surfaces as indicated. Unless otherwise indicated, extend polyurethane foam at least 4 inches (100 mm) above elevation of adjacent roof field.
5. Surface Finish: Provide finished surface of polyurethane foam within the following range of surface textures as defined by ASTM D 5469:
  - a. Texture: Smooth to orange peel **OR** coarse orange peel **OR** rippling verge of popcorn, **as directed**.
6. Remove and replace polyurethane foam not complying with minimum surface-texture limitations. Remove defective thickness and prepare and reapply polyurethane foam with acceptable, uniform results.

D. Coating Application

1. Allow polyurethane foam substrate to cure for a minimum of two hours and remove dust, dirt, water, and other contaminants before applying coating.
2. Apply coating system to polyurethane foam, in two or more coats and according to roof coating manufacturer's written instructions, by spray, roller, or other suitable application method.
3. Apply base coat and one or more topcoats to obtain a uniform, seamless membrane free of blisters and pinholes. Apply each coat at right angles to preceding coat, using contrasting colors for successive coats.
  - a. Apply base coat on same day as polyurethane foam is applied and allow it to cure.
  - b. Apply topcoat(s) after removing dust, dirt, water, and other contaminants from base coat.
  - c. Urethane Coating: Apply base coat and topcoat to a minimum dry film thickness recommend by coated foamed roofing manufacturer **OR** of 25 mils (0.64 mm) **OR** of 30 mils (0.76 mm) **OR** of 35 mils (0.89 mm), **as directed**.
  - d. Silicone Coating: Apply base coat and topcoat to a minimum dry film thickness recommend by coated foamed roofing manufacturer **OR** of 20 mils (0.50 mm) **OR** of 22 mils (0.56 mm) **OR** of 26 mils (0.66 mm) **OR** of 30 mils (0.76 mm), **as directed**.
  - e. Acrylic Coating: Apply base coat and topcoat to a minimum dry film thickness recommend by coated foamed roofing manufacturer **OR** of 25 mils (0.64 mm) **OR** of 28 mils (0.71 mm) **OR** of 32 mils (0.81 mm), **as directed**.
4. Apply coating system at wall terminations and vertical surfaces to extend beyond polyurethane foam by 4 inches (100 mm), minimum.
5. Mineral Granules: Apply mineral granules over wet topcoat using pressure equipment at the rate of 0.5 lb/sq. ft. (2.45 kg/sq. m). Remove excess granules after topcoat has cured.
6. Sealant: Apply sealant to perimeter and other terminations where indicated or required by coated foamed roofing manufacturer.
7. Walkways: Install roof walkways in pattern and locations indicated. Mask off completed roof coating adjacent to walkways and apply one or two additional topcoats to achieve a minimum dry film thickness recommended by coated foamed roofing manufacturer. Spread mineral granules uniformly at a rate of 0.5 lb/sq. ft. (2.45 kg/sq. m) into final wet coating. Remove masking and excess granules after topcoat has cured.
8. Walkways: Install roof walkways in pattern and locations indicated. Mask off completed roof coating adjacent to walkways and apply one additional topcoat to achieve a minimum dry film thickness recommended by coated foamed roofing manufacturer. Lay reinforcing fabric into wet coating and apply another topcoat, completely filling fabric. Spread mineral granules uniformly at a rate of 0.5 lb/sq. ft. (2.45 kg/sq. m) into final wet coating. Remove masking and excess granules after topcoat has cured.
9. Walkways: Install walkway pads in pattern and locations indicated. Adhere walkway pads to substrate with compatible adhesive according to coated foamed roofing manufacturer's written instructions.
10. Aggregate: Apply aggregate uniformly over coated polyurethane foam at coated foamed roofing manufacturer's recommended rate, but not less than 6 lb/sq. ft. (29 kg/sq. m) and a minimum



thickness of 3/4 inch (19 mm). Spread with care to prevent puncturing coating and to minimize damage to substrate foam.

- E. Field Quality Control
  - 1. Correct deficiencies in, or remove, foam or coatings that do not comply with requirements; fill and repair substrates and reapply materials.
  - 2. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with requirements.
  - 3. Refill cores, repair slits, and recoat test areas.
- F. Repair And Recoating
  - 1. Repair and recoat coated foamed roofing according to ASTM D 6705 and coated foamed roofing manufacturer's written instructions.
- G. Curing, Protecting, And Cleaning
  - 1. Cure coatings according to coated foamed roofing manufacturer's written instructions, taking care to prevent contamination and damage during application stages and curing. Do not permit traffic on uncured coatings.
  - 2. Protect coated foamed roofing from damage and wear during remainder of construction period.
  - 3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 65 16 00c

**SECTION 07 91 23 00 - JOINT SEALANTS**

## 1.1 GENERAL

## A. Description Of Work:

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

## B. Summary

1. Section Includes:
  - a. Silicone joint sealants.
  - b. Urethane joint sealants.
  - c. Polysulfide joint sealants.
  - d. Latex joint sealants.
  - e. Solvent-release-curing joint sealants.
  - f. Preformed joint sealants.
  - g. Acoustical joint sealants.

## C. Preconstruction Testing

1. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
  - a. Use ASTM C 1087 **OR** manufacturer's standard test method, **as directed**, to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
  - b. Submit not fewer than eight pieces of each kind of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
  - c. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
  - d. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
  - e. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.
2. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
  - a. Locate test joints where indicated on Project or, if not indicated, as directed by the Owner.
  - b. Conduct field tests for each application indicated below:
    - 1) Each kind of sealant and joint substrate indicated.
  - c. Notify the Owner seven days in advance of dates and times when test joints will be erected.
  - d. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
    - 1) Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
      - a) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
  - e. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
  - f. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with



requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

#### D. Submittals

1. Product Data: For each joint-sealant product indicated.
2. LEED Submittal:
  - a. Product Data for Credit EQ 4.1: For sealants and sealant primers used inside the weatherproofing system, including printed statement of VOC content.
3. Samples: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
4. Joint-Sealant Schedule: Include the following information:
  - a. Joint-sealant application, joint location, and designation.
  - b. Joint-sealant manufacturer and product name.
  - c. Joint-sealant formulation.
  - d. Joint-sealant color.
5. Qualification Data: For qualified Installer and testing agency.
6. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.
7. Sealant, Waterproofing, and Restoration Institute (SWRI) Validation Certificate: For each sealant specified to be validated by SWRI's Sealant Validation Program.
8. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.
9. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
  - a. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
  - b. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
10. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
11. Field-Adhesion Test Reports: For each sealant application tested.
12. Warranties: Sample of special warranties.

#### E. Quality Assurance

1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.
3. Product Testing: Test joint sealants using a qualified testing agency.
  - a. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
  - b. Test according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.
4. Preinstallation Conference: Conduct conference at Project site.

#### F. Project Conditions

1. Do not proceed with installation of joint sealants under the following conditions:
  - a. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C, **as directed**).
  - b. When joint substrates are wet.
  - c. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.



- d. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

#### G. Warranty

1. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  - a. Warranty Period: Two years from date of Final Completion.
2. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
  - a. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
  - b. Disintegration of joint substrates from natural causes exceeding design specifications.
  - c. Mechanical damage caused by individuals, tools, or other outside agents.
  - d. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

### 1.2 PRODUCTS

#### A. Materials, General

1. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
2. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):
  - a. Architectural Sealants: 250 g/L.
  - b. Sealant Primers for Nonporous Substrates: 250 g/L.
  - c. Sealant Primers for Porous Substrates: 775 g/L.
3. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
  - a. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.
4. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
5. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
6. Colors of Exposed Joint Sealants: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

#### B. Silicone Joint Sealants

1. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.
2. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
3. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
4. Single-Component, Nonsag, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.



5. Single-Component, Nonsag, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use T.
6. Single-Component, Pourable, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade P, Class 100/50, for Use T.
7. Multicomponent, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use NT.
8. Multicomponent, Pourable, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type M, Grade P, Class 100/50, for Use T.
9. Mildew-Resistant, Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
10. Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

#### C. Urethane Joint Sealants

1. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.
2. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
3. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
4. Single-Component, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use T.
5. Single-Component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.
6. Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use NT.
7. Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use NT.
8. Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use T.
9. Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.
10. Immersible, Single-Component, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Uses T and I.
11. Immersible, Single-Component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Uses T and I.
12. Immersible Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Uses T and I.
13. Immersible Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade P, Class 25, for Use T and I.

#### D. Polysulfide Joint Sealants

1. Single-Component, Nonsag, Polysulfide Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
2. Multicomponent, Nonsag, Polysulfide Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use NT.
3. Multicomponent, Nonsag, Traffic-Grade, Polysulfide Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.
4. Multicomponent, Pourable, Traffic-Grade, Polysulfide Joint Sealant: ASTM C 920, Type M, Grade P, Class 25, for Use T.
5. Immersible, Multicomponent Nonsag, Traffic-Grade, Polysulfide Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T and Use I.

#### E. Latex Joint Sealants

1. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.



- F. Solvent-Release-Curing Joint Sealants
1. Acrylic-Based Joint Sealant: ASTM C 1311.
  2. Butyl-Rubber-Based Joint Sealant: ASTM C 1311.
- G. Preformed Joint Sealants
1. Preformed Silicone Joint Sealants: Manufacturer's standard sealant consisting of precured low-modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral-curing silicone sealant for bonding extrusions to substrates.
  2. Preformed Foam Joint Sealant: Manufacturer's standard preformed, precompressed, open-cell foam sealant manufactured from urethane foam with minimum density of 10 lb/cu. ft. (160 kg/cu. m) and impregnated with a nondrying, water-repellent agent. Factory produce in precompressed sizes in roll or stick form to fit joint widths indicated; coated on one side with a pressure-sensitive adhesive and covered with protective wrapping.
- H. Acoustical Joint Sealants
1. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
- I. Joint Sealant Backing
1. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
  2. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) **OR** Type O (open-cell material) **OR** Type B (bicellular material with a surface skin) **OR** any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, **as directed**, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
  3. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.
- J. Miscellaneous Materials
1. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
  2. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
  3. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

### 1.3 EXECUTION

#### A. Examination

1. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### B. Preparation

1. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:



- a. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
- b. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
  - 1) Concrete.
  - 2) Masonry.
  - 3) Unglazed surfaces of ceramic tile.
  - 4) Exterior insulation and finish systems.
- c. Remove laitance and form-release agents from concrete.
- d. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
  - 1) Metal.
  - 2) Glass.
  - 3) Porcelain enamel.
  - 4) Glazed surfaces of ceramic tile.
2. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
3. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

### C. Installation Of Joint Sealants

1. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
2. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
3. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  - a. Do not leave gaps between ends of sealant backings.
  - b. Do not stretch, twist, puncture, or tear sealant backings.
  - c. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
4. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
5. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
  - a. Place sealants so they directly contact and fully wet joint substrates.
  - b. Completely fill recesses in each joint configuration.
  - c. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
6. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
  - a. Remove excess sealant from surfaces adjacent to joints.



- b. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
  - c. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
  - d. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.
  - e. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.
    - 1) Use masking tape to protect surfaces adjacent to recessed tooled joints.
7. Installation of Preformed Silicone-Sealant System: Comply with the following requirements:
- a. Apply masking tape to each side of joint, outside of area to be covered by sealant system.
  - b. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone-sealant system manufacturer's written instructions and covering a bonding area of not less than 3/8 inch (10 mm). Hold edge of sealant bead 1/4 inch (6 mm) inside masking tape.
  - c. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
  - d. Complete installation of sealant system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.
8. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping. Do not pull or stretch material. Produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures, apply heat to sealant in compliance with sealant manufacturer's written instructions.
9. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.
- D. Field Quality Control
1. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
- a. Extent of Testing: Test completed and cured sealant joints as follows:
    - 1) Perform 10 tests for the first 1000 feet (300 m) of joint length for each kind of sealant and joint substrate.
    - 2) Perform 1 test for each 1000 feet (300 m) of joint length thereafter or 1 test per each floor per elevation.
  - b. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
    - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
  - c. Inspect tested joints and report on the following:
    - 1) Whether sealants filled joint cavities and are free of voids.
    - 2) Whether sealant dimensions and configurations comply with specified requirements.
    - 3) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
  - d. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
  - e. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.



2. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.
- E. Cleaning
1. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.
- F. Protection
1. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Final Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.
- G. Joint-Sealant Schedule
1. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
    - a. Joint Locations:
      - 1) Control and expansion joints in brick pavers.
      - 2) Isolation and contraction joints in cast-in-place concrete slabs.
      - 3) Joints between plant-precast architectural concrete paving units.
      - 4) Joints in stone paving units, including steps.
      - 5) Tile control and expansion joints.
      - 6) Joints between different materials listed above.
      - 7) Other joints as indicated.
    - b. Silicone Joint Sealant: Single component, nonsag, traffic grade, neutral curing **OR** Single component, pourable, traffic grade, neutral curing **OR** Multicomponent, pourable, traffic grade, neutral curing, **as directed**.
    - c. Urethane Joint Sealant: Single component, nonsag, traffic grade **OR** Single component, pourable, traffic grade **OR** Multicomponent, nonsag, traffic grade, Class 50 **OR** Multicomponent, nonsag, traffic grade, Class 25, **as directed**.
    - d. Polysulfide Joint Sealant: Multicomponent, nonsag, traffic grade **OR** Multicomponent, pourable, traffic grade, **as directed**.
    - e. Preformed Joint Sealant: Preformed foam sealant.
    - f. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.
  2. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces subject to water immersion.
    - a. Joint Locations:
      - 1) Joints in pedestrian plazas.
      - 2) Joints in swimming pool decks.
      - 3) Other joints as indicated.
    - b. Urethane Joint Sealant: Immersible, single component, nonsag, traffic grade **OR** Immersible, single component, pourable, traffic grade **OR** Immersible, multicomponent, nonsag, traffic grade **OR** Immersible, multicomponent, pourable, traffic grade, **as directed**.
    - c. Polysulfide Joint Sealant: Immersible, multicomponent, nonsag, traffic grade.
    - d. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.
  3. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
    - a. Joint Locations:
      - 1) Construction joints in cast-in-place concrete.
      - 2) Joints between plant-precast architectural concrete units.
      - 3) Control and expansion joints in unit masonry.
      - 4) Joints in dimension stone cladding.



- 5) Joints in glass unit masonry assemblies.
- 6) Joints in exterior insulation and finish systems.
- 7) Joints between metal panels.
- 8) Joints between different materials listed above.
- 9) Perimeter joints between materials listed above and frames of doors, windows and louvers.
- 10) Control and expansion joints in ceilings and other overhead surfaces.
- 11) Other joints as indicated.
- b. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 100/50 **OR** Single component, nonsag, neutral curing, Class 50 **OR** Single component, nonsag, neutral curing, Class 25 **OR** Single component, nonsag, acid curing **OR** Multicomponent, nonsag, neutral curing, **as directed**.
- c. Urethane Joint Sealant: Single component, nonsag, Class 100/50 **OR** Single component, nonsag, Class 50 **OR** Single component, nonsag, Class 25 **OR** Multicomponent, nonsag,, Class 50 **OR** Multicomponent, nonsag,, Class 25, **as directed**.
- d. Polysulfide Joint Sealant: Single component, nonsag **OR** Multicomponent, nonsag, **as directed**.
- e. Preformed Joint Sealant: Preformed silicone **OR** Preformed foam, **as directed**.
- f. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.
4. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
  - a. Joint Locations:
    - 1) Isolation joints in cast-in-place concrete slabs.
    - 2) Control and expansion joints in stone flooring.
    - 3) Control and expansion joints in brick flooring.
    - 4) Control and expansion joints in tile flooring.
    - 5) Other joints as indicated.
  - b. Silicone Joint Sealant: Single component, nonsag, traffic grade, neutral curing **OR** Single component, pourable, traffic grade, neutral curing **OR** Multicomponent, pourable, traffic grade, neutral curing, **as directed**.
  - c. Urethane Joint Sealant: Single component, nonsag, traffic grade **OR** Single component, pourable, traffic grade **OR** Multicomponent, nonsag, traffic grade, Class 50 **OR** Multicomponent, nonsag, traffic grade, Class 25, **as directed**.
  - d. Polysulfide Joint Sealant: Multicomponent, nonsag, traffic grade **OR** Multicomponent, pourable, traffic grade, **as directed**.
  - e. Preformed Joint Sealant: Preformed foam.
  - f. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.
5. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
  - a. Joint Locations:
    - 1) Control and expansion joints on exposed interior surfaces of exterior walls.
    - 2) Perimeter joints of exterior openings where indicated.
    - 3) Tile control and expansion joints.
    - 4) Vertical joints on exposed surfaces of interior unit masonry and concrete walls and partitions.
    - 5) Joints on underside of plant-precast structural concrete beams and planks.
    - 6) Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.
    - 7) Other joints as indicated.
  - b. Joint Sealant: Latex **OR** Acrylic based **OR** Butyl rubber based, **as directed**.
  - c. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.
6. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
  - a. Joint Sealant Location:
    - 1) Joints between plumbing fixtures and adjoining walls, floors, and counters.



- 2) Tile control and expansion joints where indicated.
- 3) Other joints as indicated.
- b. Joint Sealant: Mildew resistant, single component, nonsag, neutral curing, Silicone **OR** Single component, nonsag, mildew resistant, acid curing, **as directed**.
- c. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.
- 7. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces.
  - a. Joint Location:
    - 1) Acoustical joints where indicated.
    - 2) Other joints as indicated.
  - b. Joint Sealant: Acoustical.
  - c. Joint-Sealant Color: As selected from manufacturer's full range.

END OF SECTION 07 91 23 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
07 91 26 00	07 91 23 00	Joint Sealants
07 92 13 00	07 91 23 00	Joint Sealants
07 92 19 00	07 91 23 00	Joint Sealants



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**SECTION 07 95 13 13 - ARCHITECTURAL JOINT SYSTEMS**

## 1.1 GENERAL

## A. Description Of Work

1. This specification covers the furnishing and installation of materials for architectural joint systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.
2. See Division 03 Section "Cast-in-place Concrete" for cast-in architectural-joint-system frames furnished, but not installed, in this Section.

## B. Definitions

1. Maximum Joint Width: Widest linear gap a joint system tolerates and in which it performs its designed function without damaging its functional capabilities.
2. Minimum Joint Width: Narrowest linear gap a joint system tolerates and in which it performs its designed function without damaging its functional capabilities.
3. Movement Capability: Value obtained from the difference between widest and narrowest widths of a joint opening typically expressed in numerical values (mm or inches) or a percentage (plus or minus) of nominal value of joint width.
4. Nominal Joint Width: The width of the linear opening specified in practice and in which the joint system is installed.

## C. Submittals

1. Shop Drawings: Provide placement drawings, including line diagrams and details, and a tabular schedule of architectural joint systems.

## D. Quality Assurance

1. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines (ADAAG)" and ICC A117.1.
2. Fire-Test-Response Characteristics: Where indicated, provide architectural joint system and fire-barrier assemblies identical to those of assemblies tested for fire resistance per UL 2079 or ASTM E 1966 by a testing and inspecting agency acceptable to authorities having jurisdiction.
  - a. Hose Stream Test: Wall-to-wall and wall-to-ceiling assemblies shall be subjected to hose stream testing.

## 1.2 PRODUCTS

## A. Materials

1. Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063-T5 for extrusions; ASTM B 209 (ASTM B 209M), Alloy 6061-T6 for sheet and plate.
  - a. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.
  - b. Mill Finish.
  - c. Clear Anodic Finish: Class II, clear anodic coating **OR** Class I, clear anodic coating, **as directed**, complying with AAMA 611.
  - d. Color Anodic Finish: Class II, color anodic coating **OR** Class I, color anodic coating, **as directed**, complying with AAMA 611.
  - e. High-Performance Organic Finish (Two-Coat Fluoropolymer): Comply with AAMA 2604 and with coating and resin manufacturers' written instructions.
2. Stainless Steel: ASTM A 666, Type 304 for plates, sheet, and strips.
3. Brass: ASTM B 36/B 36M, UNS Alloy C26000 for half hard sheet and coil.



4. Bronze: ASTM B 455, Alloy C38500 for extrusions; Alloy C23000 red brass for plates.
5. Moisture Barrier: PVC , minimum 30 mils thick **OR** EPDM, minimum 45 mils thick **OR** Santoprene, **as directed**.
6. Elastomeric Seals: Preformed elastomeric membranes or extrusions to be installed in metal frames.
7. Compression Seals: ASTM E 1612; preformed rectangular elastomeric extrusions having internal baffle system and designed to function under compression.
8. Strip Seals: ASTM E 1783; preformed elastomeric membrane or tubular extrusions having an internal baffle system and secured in or over a joint by a metal locking rail.
9. Cellular Foam Seals: Extruded, compressible foam designed to function under compression.
10. Elastomeric Concrete: Modified epoxy or polyurethane extended into a prepackaged aggregate blend, specifically designed for bonding to concrete substrates.
11. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to meet performance criteria for required rating period.
12. Accessories: Manufacturer's standard anchors, fasteners, and other accessories as required for complete installations.

#### B. Architectural Joint Systems, General

1. General: Provide joint systems of design indicated.
  - a. Furnish in longest practicable lengths to minimize splicing. Install with hairline mitered corners where joint changes direction.
  - b. Include factory-fabricated closure materials and transition pieces to provide continuous joint systems.
2. Design architectural joint systems for the following size and movement characteristics:
  - a. Nominal Joint Width: As indicated on Drawings **OR** As scheduled, **as directed**.
  - b. Movement Capability: Plus or minus 25 percent **OR** Plus or minus 50 percent **OR** Plus or minus 100 percent **OR** As indicated on Drawings **OR** As scheduled, **as directed**.
  - c. Type of Movement: As indicated on Drawings **OR** As scheduled **OR** Thermal **OR** Seismic **OR** Wind sway, **as directed**.

#### C. Architectural Joint Systems For Building Interiors

1. Floor-to-Floor and Floor-to-Wall Joint Systems:
  - a. Type: Cover plate **OR** Center plate **OR** Glide plate **OR** Hidden sightline **OR** Pan **OR** Surface mounted, **as directed**.
    - 1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
      - a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** No. 2B **OR** No. 4, **as directed**.
      - b) Color: As selected from manufacturer's full range.
  - b. Type: Elastomeric **OR** Dual elastomeric, **as directed**, seal.
    - 1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
      - a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** No. 2B **OR** No. 4, **as directed**.
      - b) Color: As selected from manufacturer's full range.
    - 2) Seal Material: Santoprene.
      - a) Color: As selected from manufacturer's full range.
  - c. Cover-Plate Design:
    - 1) Plain **OR** Serrated **OR** Abrasive filled, **as directed**.
    - 2) Recessed to accept field-applied finish materials.
      - a) Recess Depth: To accommodate adjacent flooring.
  - d. Attachment Method: Mechanical anchors **OR** Cast in, **as directed**.
  - e. Load Capacity: Standard **OR** Heavy **OR** Extra heavy, **as directed**, duty.
  - f. Fire-Resistance Rating: Match adjacent construction.
  - g. Moisture Barrier: Manufacturer's standard.
2. Wall-to-Wall and Wall Corner Joint Systems:



- a. Type: Vertical cover plate **OR** Glide plate **OR** Hidden sightline **OR** Snap-on cover **OR** Clip-in cover, **as directed**.
    - 1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
      - a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** No. 2B **OR** No. 4, **as directed**.
      - b) Color: As selected from manufacturer's full range.
  - b. Type: Elastomeric seal **OR** Dual elastomeric seal **OR** Accordion, **as directed**.
    - 1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
      - a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** No. 2B **OR** No. 4, **as directed**.
      - b) Color: As selected from manufacturer's full range.
    - 2) Seal Material: Santoprene **OR** PVC, **as directed**.
      - a) Color: As selected from manufacturer's full range.
  - c. Type: Flat seal.
    - 1) Seal Material: Santoprene.
      - a) Color: As selected from manufacturer's full range.
  - d. Fire-Resistance Rating: Match adjacent construction.
  - e. Moisture Barrier: Manufacturer's standard.
3. Wall-to-Ceiling and Ceiling-to-Ceiling Joint Systems:
- a. Type: Cover plate **OR** Glide plate **OR** Snap-on cover **OR** Clip-in cover, **as directed**.
    - 1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
      - a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** No. 2B **OR** No. 4, **as directed**.
      - b) Color: As selected from manufacturer's full range.
  - b. Type: Elastomeric seal **OR** Dual elastomeric seal **OR** Accordion, **as directed**.
    - 1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
      - a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear Color: As selected from manufacturer's full range.
      - b) Seal Material: Santoprene **OR** PVC, **as directed**.
      - c) Color: As selected from manufacturer's full range.
  - c. Type: Flat seal.
    - 1) Seal Material: Santoprene.
      - a) Color: As selected from manufacturer's full range.
  - d. Fire-Resistance Rating: Match adjacent construction.
  - e. Moisture Barrier: Manufacturer's standard.
- D. Architectural Joint Systems For Building Exteriors
- 1. Architectural Joint Systems for Exterior Walls and Soffits:
    - a. Type: Vertical cover-plate.
      - 1) Exposed Metal: Aluminum **OR** Stainless steel, **as directed**.
        - a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** Class I, color anodic **OR** Class II, color anodic **OR** High-performance organic **OR** No. 2B **OR** No. 4, **as directed**.
        - b) Color: As selected from full range of industry colors and color densities.
      - 2) Secondary Seal: Manufacturer's standard extruded-elastomeric seal designed to prevent water and moisture infiltration.
    - b. Type: Flat seal.
      - 1) Seal Material: Santoprene.
        - a) Color: As selected from manufacturer's full range.
      - 2) Secondary Seal: Manufacturer's standard extruded-elastomeric seal designed to prevent water and moisture infiltration.
      - 3) Pantograph Mechanism: Manufacturer's standard nylon pantographic wind-load support mechanism with stainless-steel fasteners.
    - c. Type: Preformed cellular foam.



- 1) Foam Material: Manufacturer's standard **OR** Non-extruded, low-density, crosslinked, nitrogen-blown, ethylene-vinyl-acetate copolymer **OR** Polyurethane, **as directed**.
    - a) Color: As selected from manufacturer's full range.
  - d. Fire-Resistance Rating: Match adjacent construction.
- E. Architectural Joint Systems For Open-Air Structures
1. Slab-to-Slab Joint Systems for Parking Structures **OR** Plaza Decks **OR** Stadiums, **as directed**:
    - a. Type: Metal plate.
      - 1) Exposed Metal: Aluminum **OR** Stainless steel, **as directed**.
        - a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** Class I, color anodic **OR** Class II, color anodic **OR** High-performance organic **OR** No. 2B **OR** No. 4, **as directed**.
        - b) Color: As selected from full range of industry colors and color densities.
      - b. Type: Sealant T-joint **OR** Rubber pad **OR** Compression seal **OR** Strip seal **OR** Winged seal **OR** Epoxy-bonded seal **OR** Split-slab membrane, **as directed**.
        - 1) Seal Material: Santoprene **OR** Neoprene **OR** Silicone **OR** EPDM **OR** PVC **OR** Manufacturer's standard, **as directed**.
          - a) Color: As selected from manufacturer's full range.
      - c. Attachment Method: Mechanical anchors **OR** Cast in **OR** Elastomeric concrete header **OR** Compressed, epoxy adhered **OR** Compressed, lubricant adhesive adhered, **as directed**.
      - d. Load Capacity: Heavy **OR** Extra heavy, **as directed**, duty.
      - e. Fire-Resistance Rating: Match adjacent construction.
      - f. Gutter: Flexible, fabric-reinforced neoprene gutter system with drain tubes.
    2. Slab-to-Wall Joint Systems for Parking Structures **OR** Plaza Decks **OR** Stadiums, **as directed**:
      - a. Type: Metal plate.
        - 1) Exposed Metal: Aluminum **OR** Stainless steel, **as directed**.
          - a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** Class I, color anodic **OR** Class II, color anodic **OR** High-performance organic **OR** No. 2B **OR** No. 4, **as directed**.
          - b) Color: As selected from full range of industry colors and color densities.
        - b. Type: Sealant T-joint **OR** Rubber pad **OR** Compression seal **OR** Strip seal **OR** Winged seal **OR** Epoxy-bonded seal **OR** Split-slab membrane, **as directed**.
          - 1) Seal Material: Santoprene **OR** Neoprene **OR** Silicone **OR** EPDM **OR** PVC **OR** Manufacturer's standard, **as directed**.
            - a) Color: As selected from manufacturer's full range.
        - c. Attachment Method: Mechanical anchors **OR** Cast in **OR** Elastomeric concrete header **OR** Compressed, epoxy adhered **OR** Compressed, lubricant adhesive adhered, **as directed**.
        - d. Fire-Resistance Rating: Match adjacent construction.
        - e. Gutter: Flexible, fabric reinforced neoprene gutter system with drain tubes.
      3. Wall-to-Wall Joint Systems for Parking Structures **OR** Plaza Decks **OR** Stadiums, **as directed**:
        - a. Type: Compression seal.
          - 1) Seal Material: Santoprene **OR** Neoprene **OR** Silicone **OR** EPDM **OR** PVC **OR** Manufacturer's standard, **as directed**.
            - a) Color: As selected from manufacturer's full range.
        - b. Type: Preformed cellular foam.
          - 1) Foam Material: Manufacturer's standard **OR** Non-extruded, low-density, crosslinked, nitrogen-blown, ethylene-vinyl-acetate copolymer **OR** Polyurethane, **as directed**.
            - a) Color: As selected from manufacturer's full range.
        - c. Attachment Method: Mechanical anchors **OR** Cast in **OR** Compressed, epoxy adhered **OR** Compressed, lubricant adhesive adhered, **as directed**.
        - d. Fire-Resistance Rating: Match adjacent construction.

F. Finishes



1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable.

### 1.3 EXECUTION

#### A. Installation

1. Comply with manufacturer's written instructions for storing, handling, and installing architectural joint assemblies and materials unless more stringent requirements are indicated.
2. Metal Frames: Perform cutting, drilling, and fitting required to install joint systems.
  - a. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
  - b. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
  - c. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
  - d. Locate in continuous contact with adjacent surfaces.
  - e. Support underside of frames continuously to prevent vertical deflection when in service.
  - f. Locate anchors at interval recommended by manufacturer, but not less than 3 inches (75 mm) from each end and not more than 24 inches (600 mm) o.c.
3. Seals in Metal Frames: Install elastomeric seals in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.
  - a. Provide in continuous lengths for straight sections.
  - b. Seal transitions according to manufacturer's written instructions.
4. Compression Seals: Apply adhesive or lubricant adhesive as recommended by manufacturer to both frame interfaces **OR** sides of slabs, **as directed**, before installing compression seals.
5. Foam Seals: Install with adhesive recommended by manufacturer.
6. Epoxy-Bonded Seals: Pressurize seal for time period and to pressure recommended by manufacturer. Do not overpressurize.
7. Terminate exposed ends of joint assemblies with field- or factory-fabricated termination devices.
8. Fire-Resistance-Rated Assemblies: Coordinate so complete assemblies comply with assembly performance requirements.
  - a. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.
9. Water Barrier: Provide water barrier at exterior joints and where called for on Drawings.

#### B. Protection

1. Do not remove protective covering until finish work in adjacent areas is complete.
2. Protect the installation from damage by work of other Sections.

END OF SECTION 07 95 13 13



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## SECTION 07 95 13 16 - ROOF EXPANSION ASSEMBLIES

### 1.1 GENERAL

#### A. Description Of Work:

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

#### B. Summary

1. This Section includes the following:
  - a. Metal-flanged, bellows-type roof expansion assemblies.
  - b. Aluminum roof expansion assemblies.
  - c. Seismic roof expansion assemblies.

#### C. Performance Requirements

1. General: Provide roof expansion assemblies that, when installed, remain watertight within movement limitations specified by manufacturer.

#### D. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: Include plans, elevations, sections, details, joints, splices, locations of joints and splices, intersections, transitions, fittings, and attachments to other work. Where joint assemblies change planes, provide isometric drawings depicting how components interconnect to achieve continuity.
3. Samples: For each type of exposed factory-applied finish required, prepared on Samples of size to adequately show color.
4. Research/Evaluation Reports: For roof expansion assemblies.
5. Warranties: Special warranties specified in this Section.

#### E. Quality Assurance

1. Fire-Test-Response Characteristics: Provide fire-barrier assemblies with fire-test-response characteristics not less than that of adjacent construction, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Assemblies shall be capable of anticipated movement while maintaining fire rating. Identify assemblies with appropriate markings of applicable testing and inspecting agency.
  - a. Fire-Resistance Ratings: UL 2079 **OR** ASTM E 119, **as directed**.

#### F. Warranty

1. Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace roof expansion assemblies that leak, deteriorate in excess of rates specified in manufacturer's published product literature, or otherwise fail to perform within Two years from date of Final Completion.
2. Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied fluoropolymer finishes within 20 years from date of Final Completion.

### 1.2 PRODUCTS

#### A. Metals



1. Galvanized Steel Sheet: ASTM A 653/A 653M, hot-dip zinc-coating designation G90 (Z275), stretcher-leveled standard of flatness and either commercial or forming steel, minimum 0.019 inch (0.5 mm) thick.
2. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness, minimum 0.015 inch (0.4 mm) thick.
3. Copper Sheet: ASTM B 370, Temper H00 (cold rolled) unless Temper 060 is required for forming, minimum 16 oz./sq. ft. (0.55 mm thick).
4. Sheet Aluminum: ASTM B 209 (ASTM B 209M); Alloy 3003-H14, 5052-H32, or 6061-T6; minimum 0.032 inch (0.8 mm) thick.
5. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063-T5 or 6063-T52, minimum 0.040 inch (1.0 mm) thick.
6. Aluminum Finishes:
  - a. Mill Finish: AA-M10 (Mechanical Finish: as fabricated; no other applied finish unless buffing is required to removed scratches, welding, or grinding produced in fabrication process).
  - b. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
  - c. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
  - d. Class II, Color Anodic Finish: AA-M12C22A32/A34 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker).
  - e. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
    - 1) Color: As selected from manufacturer's full range.
  - f. High-Performance Organic Finish (2-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2604 and with coating and resin manufacturers' written instructions.
    - 1) Color and Gloss: As selected from manufacturer's full range.

#### B. Miscellaneous Materials

1. Roof Cement: ASTM D 4586, Type II.
2. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane **OR** polysulfide **OR** silicone, **as directed**, polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and to remain watertight.
3. Mineral-Fiber Blanket: ASTM C 665.
4. Flexible Cellular Sponge or Expanded Rubber: ASTM D 1056.
5. Silicone Extrusions: Classified according to ASTM D 2000, UV stabilized, and do not propagate flame.
6. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to withstand design loads.
  - a. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.

#### C. Fire Barriers

1. Fire Barriers: Devices complying with requirements specified in Part 1.1 "Quality Assurance" Article for fire-test-response characteristics and designed for dynamic structural movement



without material degradation or fatigue when tested according to ASTM E 1399. Provide roof expansion assemblies with manufacturer's continuous, standard, flexible fire-barrier seals in back of joint system at locations indicated to provide fire-resistance rating not less than rating of adjacent construction.

D. Bellows-Type Roof Expansion Assemblies

1. Metal-Flanged, Bellows-Type Roof Expansion Assemblies: Provide manufacturer's standard assemblies of sizes and types indicated, with prefabricated units for corner and joint intersections and horizontal and vertical transitions including those to other building expansion joints, splicing units, adhesives, coatings, and other components as recommended by roof expansion assembly manufacturer for complete installation. Fabricate assemblies specifically for roof-to-roof **OR** roof-to-wall **OR** curb-to-curb **OR** curb-to-wall, **as directed**, applications.
2. Provide assemblies consisting of exposed polymeric sheet over foam bellows, securely anchored at both edges to 3- to 4-inch- (76- to 100-mm-) wide sheet metal nailing flanges, either flat or angle formed to fit cant or curbs as required. Insulate bellows with closed-cell, flexible rubber or plastic foam not less than 5/16 inch (8 mm) thick; adhere bellows to underside of polymeric sheet.
  - a. Polymeric Sheet: Manufacturer's standard **OR** Neoprene, 60 mils (1.5 mm) thick **OR** EPDM, 60 mils (1.5 mm) thick, black **OR** EPDM, 60 mils (1.5 mm) thick, white **OR** Reinforced chlorinated polyethylene, 30 mils (0.8 mm) thick **OR** Chlorosulfonated polyethylene, 36 mils (0.9 mm) thick **OR** Glass-reinforced PVC, 40 to 50 mils (1.0 to 1.3 mm) thick, **as directed**.
  - b. Metal Flanges: Zinc-coated (galvanized) steel, minimum 0.019 inch (0.5 mm) thick **OR** Copper, minimum 16 oz./sq. ft. (0.55 mm thick) **OR** Stainless steel, minimum 0.015 inch (0.4 mm) thick **OR** Sheet aluminum, minimum 0.032 inch (0.8 mm) thick, mill finish, **as directed**.
    - 1) Mortar Flanges: Where flanges will be embedded in concrete or mortar, provide manufacturer's standard perforated-metal mortar flanges.
  - c. Moisture Barrier: Manufacturer's standard, flexible, continuous, polymeric moisture barrier looped under roof expansion assemblies at locations indicated. Fill space with blanket-type, mineral-fiber insulation.
  - d. Fire Barrier: Provide manufacturer's standard fire barrier.

E. Aluminum Roof Expansion Assemblies

1. Aluminum Roof Expansion Assemblies: Provide assemblies consisting of aluminum base members with sloped cants and provisions for anchoring and sealing to roofing membrane or flashing in a waterproof-sealed joint. Provide free-to-move, extruded-aluminum cover plate anchored against displacement and waterproofed by integral seals. Provide prefabricated units for corner and joint intersections and horizontal and vertical transitions, including those to other building expansion joints, splicing units, adhesives, coatings, and other components as recommended by roof expansion assembly manufacturer for complete installation. Fabricate assemblies specifically for curb-to-curb **OR** wall, **as directed**, applications.
  - a. Base Frame Members: Extruded aluminum with mill **OR** anodic **OR** high-performance organic, **as directed**, finish.
  - b. Extruded-Aluminum Covers: Minimum 0.080 inch (2.03 mm) **OR** 0.125 inch (3 mm), **as directed**, thick, with mill **OR** clear anodic **OR** color anodic **OR** high-performance organic, **as directed**, finish.
  - c. Formed-Aluminum Covers: Minimum 0.078 inch (2 mm) thick, with mill **OR** clear anodic **OR** color anodic **OR** high-performance organic, **as directed**, finish.
  - d. Moisture Barrier:
    - 1) Semiconcealed, captive, polymeric sheet bellows unit of neoprene, EPDM, reinforced chlorinated polyethylene, or PVC, not less than 30 mils (0.8 mm) thick.
    - 2) Semiconcealed, captive gaskets at both curb members, of neoprene, EPDM, or PVC, with spring-loaded mechanism to maintain positive pressure between gaskets and curb cap.
  - e. Fire Barrier: Provide manufacturer's standard fire barrier.



#### F. Seismic Roof Expansion Assemblies

1. General: Provide manufacturer's assemblies designed to accommodate seismic movement. Provide prefabricated units for corner and joint intersections and horizontal and vertical transitions including those to other building expansion joints, splicing units, inner seals, adhesives, coatings, and other components as recommended by roof expansion assembly manufacturer for complete installation. Fabricate assemblies specifically for roof-to-roof **OR** roof-to-wall **OR** curb-mounted, **as directed**, applications.
2. Extruded Seals: Two continuous, single-layered elastomeric profiles made of a vinyl inner seal and silicone **OR** neoprene **OR** Santoprene, **as directed**, outer seal, both seals retained in a pair of compatible extruded-aluminum frames.
  - a. Exterior Seal Color: As selected from manufacturer's full range.
3. Aluminum Roof Expansion Assemblies: Assemblies consisting of pairs of aluminum curb units with sloped cants and provisions for anchoring and sealing to roofing membrane or flashing in a waterproof-sealed joint. Provide free-to-move, extruded-aluminum curb cap anchored against displacement and waterproofed by integral seals, with interior of expansion joint filled with blanket-type mineral-fiber insulation.
  - a. Base Frame Members: Extruded aluminum with mill **OR** clear anodic **OR** color anodic **OR** high-performance organic, **as directed**, finish.
  - b. Extruded-Aluminum Covers: Minimum 0.080 inch (2.03 mm) **OR** 0.125 inch (3 mm), **as directed**, thick, with mill **OR** clear anodic **OR** color anodic **OR** high-performance organic, **as directed**, finish.
  - c. Formed-Aluminum Covers: Minimum 0.078 inch (2 mm) thick, with mill **OR** clear anodic **OR** color anodic **OR** high-performance organic, **as directed**, finish.
  - d. Moisture Barrier:
    - 1) Semiconcealed, captive, polymeric sheet bellows unit of neoprene, EPDM, reinforced chlorinated polyethylene, or PVC, not less than 30 mils (0.8 mm) thick.
    - 2) Semiconcealed, captive gaskets at both curb members, of neoprene, EPDM, or PVC, with spring-loaded mechanism to maintain positive pressure between gaskets and curb cap.
  - e. Fire Barrier: Provide manufacturer's standard fire barrier.

### 1.3 EXECUTION

#### A. Installation

1. Comply with manufacturer's written instructions for handling and installing roof expansion assemblies and materials unless more stringent requirements are indicated.
2. Coordinate installation of roof expansion assembly materials and associated work so complete assemblies comply with assembly performance requirements.
3. Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of roof expansion assembly, including transitions and end joints.
4. Extend roof expansion assemblies over curbs, parapets, cornices, gutters, valleys, fasciae, and other elements in the construction profile, with factory-fabricated intersections and transitions to provide continuous, uninterrupted, waterproof roof expansion assemblies.
  - a. Install factory-fabricated transitions between roof expansion assemblies and building architectural joint systems, specified in Division 07 Section "Expansion Control", to provide continuous, uninterrupted, watertight construction.
5. Splice roof expansion assemblies with materials provided by roof expansion assembly manufacturer for this purpose, according to manufacturer's written instructions, to provide continuous, uninterrupted, waterproof roof expansion assemblies.
6. Provide uniform profile of roof expansion assembly throughout length of each installation; do not stretch polymeric sheets.
7. Install mineral-fiber blanket insulation to fill joint space within joint and moisture barrier.
8. Bed anchorage flanges in cement or sealant recommended by manufacturer and securely nail to curbs and cant strips as recommended by manufacturer but not less than 6 inches (150 mm) o.c.



9. Anchor roof expansion assemblies complying with manufacturer's written instructions.
  10. Embed flanges not less than 4 inches (100 mm) in bituminous membranes, with hot bitumen or roof cement. Cover with stripping material and install according to requirements in roofing section.
  11. On single-ply roofing, install roof expansion assemblies complying with manufacturer's written instructions. Anchor to cants or curbs and seal to membrane with sealant compatible with roofing membrane and roof expansion assembly. Cover flanges with stripping or flashing and install according to requirements in roofing section.
- B. Protection
1. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensures that roof expansion assemblies are without damage or deterioration at time of Final Completion.

END OF SECTION 07 95 13 16



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
07 95 13 16	07 95 13 13	Architectural Joint Systems

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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. Stone thresholds.
  - c. Waterproof membrane.
  - d. Crack isolation membrane.
  - e. Tile backing panels.
  - f. Metal edge strips.

#### C. Definitions

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

#### D. Performance Requirements

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

#### E. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittal:
  - a. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
4. Samples:
  - a. Full-size units of each type and composition of tile and for each color and finish required. For ceramic mosaic tile in color blend patterns, provide full sheets of each color blend.  
**OR**  
Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 12 inches (300 mm) square, but not fewer than 4 tiles. Use grout of type and in color or colors approved for completed Work.



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

#### F. Quality Assurance

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

#### G. Delivery, Storage, And Handling

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

#### H. Project Conditions

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

## 1.2 PRODUCTS

#### A. Products, General

- 1. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
  - a. Provide tile complying with Standard grade requirements unless otherwise indicated.
- 2. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 1.2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.



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

#### B. Tile Products

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

**OR**



- Internal Corners: Field-butteted 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-buttet square corners. For coved base and cap use angle pieces designed to fit with stretcher shapes.
5. Accessories: Provide vitreous china accessories of type and size indicated, suitable for installing by same method as adjoining wall tile.
- a. One soap holder with grab handle, **as directed**, for each shower and tub indicated.
  - b. One paper holder at each water closet.
  - c. Color and Finish: Match adjoining glazed wall tile **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full range **OR** White, bright glaze, **as directed**.

#### C. Thresholds

- 1. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
  - a. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch (1.5 mm) above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch (12.7 mm) or less above adjacent floor surface.
- 2. Granite Thresholds: ASTM C 615, with polished **OR** honed, **as directed**, finish.
  - a. Description: Uniform, fine **OR** medium, **as directed**,-grained, white **OR** gray **OR** black, **as directed**, stone without veining.  
**OR**  
Description: Match sample.



3. Marble Thresholds: ASTM C 503, with a minimum abrasion resistance of 10 **OR** 12, **as directed**, per ASTM C 1353 or ASTM C 241 and with honed finish.
    - a. Description: Uniform, fine- to medium-grained white stone with gray veining.  
**OR**  
Description: Match sample.
  4. Slate Thresholds: ASTM C 629, Classification I Exterior **OR** II Interior, **as directed**, with fine, even grain and honed finish.
    - a. Description: Uniform, black **OR** blue-black **OR** gray **OR** blue-gray **OR** green, **as directed**, stone and unfading.  
**OR**  
Description: Match sample.
- D. Tile Backing Panels
1. Cementitious Backer Units: ANSI A118.9 or ASTM C 1325, in maximum lengths available to minimize end-to-end butt joints.
    - a. Thickness: 1/4 inch (6.4 mm) **OR** 1/2 inch (12.7 mm) **OR** 5/8 inch (15.9 mm) **OR** As indicated, **as directed**.
  2. Fiber-Cement Underlayment: ASTM C 1288, in maximum lengths available to minimize end-to-end butt joints.
    - a. Thickness: 1/4 inch (6.4 mm) **OR** 1/2 inch (12.7 mm) **OR** As indicated, **as directed**.
- E. Waterproof Membrane
1. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
  2. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch (0.76-mm) nominal thickness.
  3. PVC Sheet: Two layers of PVC sheet heat-fused together and to facings of nonwoven polyester; 0.040-inch (1.01-mm) nominal thickness.
  4. Polyethylene Sheet: Polyethylene faced on both sides with fleece webbing; 0.008-inch (0.203-mm) nominal thickness.
  5. Fabric-Reinforced, Modified-Bituminous Sheet: Self-adhering, SBS-modified-bituminous sheet with woven reinforcement facing; 0.040-inch (1.01-mm) nominal thickness.
  6. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.
  7. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
  8. Latex-Portland Cement: Flexible mortar consisting of cement-based mix and latex additive.
  9. Urethane Waterproofing and Tile-Setting Adhesive: One-part, liquid-applied urethane, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), in a consistency suitable for trowel application and intended for use as both waterproofing and tile-setting adhesive in a two-step process.
- F. Crack Isolation Membrane
1. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.12 for standard **OR** high, **as directed**, performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
  2. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch (0.76-mm) nominal thickness.
  3. PVC Sheet: Two layers of PVC sheet heat-fused together and to facings of nonwoven polyester; 0.040-inch (1.01-mm) nominal thickness.
  4. Polyethylene Sheet: Polyethylene faced on both sides with fleece webbing; 0.008-inch (0.203-mm) nominal thickness.
  5. Corrugated Polyethylene: Corrugated polyethylene with dovetail-shaped corrugations and with anchoring webbing on the underside; 3/16-inch (4-mm) nominal thickness.



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

#### G. Setting Materials

1. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
  - a. Cleavage Membrane: Asphalt felt, ASTM D 226, Type I (No. 15); or polyethylene sheeting, ASTM D 4397, 4.0 mils (0.1 mm) thick.
  - b. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches (50.8 by 50.8 mm) by 0.062-inch (1.57-mm) diameter; comply with ASTM A 185 and ASTM A 82 except for minimum wire size.
  - c. Expanded Metal Lath: Diamond-mesh lath complying with ASTM C 847.
    - 1) Base Metal and Finish for Interior Applications: Uncoated or zinc-coated (galvanized) steel sheet, with uncoated steel sheet painted after fabrication into lath.
    - 2) Base Metal and Finish for Exterior Applications: Zinc-coated (galvanized) steel sheet.
    - 3) Configuration over Studs and Furring: Flat.
    - 4) Configuration over Solid Surfaces: Self furring.
    - 5) Weight: 2.5 lb/sq. yd. (1.4 kg/sq. m) **OR** 3.4 lb/sq. yd. (1.8 kg/sq. m), **as directed**.
  - d. Latex Additive: Manufacturer's standard, acrylic resin or styrene-butadiene-rubber water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.
2. Dry-Set Portland Cement Mortar (Thin Set): ANSI A118.1.
  - a. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.1.
3. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.
  - a. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.  
**OR**  
Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
  - b. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
4. Medium-Bed, Latex-Portland Cement Mortar: Comply with requirements in ANSI A118.4. Provide product that is approved by manufacturer for application thickness of 5/8 inch (16 mm).
  - a. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.  
**OR**  
Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
5. EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar (Thin Set): ANSI A118.11.
  - a. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
  - b. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
6. Water-Cleanable, Tile-Setting Epoxy: ANSI A118.3, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).



- a. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 deg F (60 deg C) and 212 deg F (100 deg C), respectively, and certified by manufacturer for intended use.
7. Chemical-Resistant Furan Mortar: ANSI A118.5, with carbon filler.
8. Organic Adhesive: ANSI A136.1, Type I, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

#### H. Grout Materials

1. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.
  2. Standard Cement Grout: ANSI A118.6.
  3. Polymer-Modified Tile Grout: ANSI A118.7.
    - a. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.

**OR**

Polymer Type: Acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.
4. Water-Cleanable Epoxy Grout: ANSI A118.3.
    - a. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 deg F (60 deg C) and 212 deg F (100 deg C), respectively, and certified by manufacturer for intended use.
  5. Chemical-Resistant Furan Grout: ANSI A118.5, with carbon filler.
  6. Grout for Pregrouted Tile Sheets: Same product used in factory to pregrout tile sheets.

#### I. Elastomeric Sealants

1. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements and with the applicable requirements in Division 7 Section "Joint Sealants."
  - a. Use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - b. Use primers, backer rods, and sealant accessories recommended by sealant manufacturer.
2. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated.
3. One-Part, Mildew-Resistant Silicone Sealant: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.
4. Multipart, Pourable Urethane Sealant for Use T: ASTM C 920; Type M; Grade P; Class 25; Uses T, M, A, and, as applicable to joint substrates indicated, O.
5. Chemical-Resistant Sealants: For chemical-resistant floors, provide chemical-resistant elastomeric sealant of type recommended and produced by chemical-resistant mortar and grout manufacturer for type of application indicated, with proven service record and compatibility with tile and other setting materials, and with chemical resistance equivalent to mortar/grout.

#### J. Miscellaneous Materials

1. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
2. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; half-hard brass **OR** white zinc alloy **OR** nickel silver **OR** stainless-steel, ASTM A 666, 300 Series, **as directed**, exposed-edge material.



3. Temporary Protective Coating: Either product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.
  - a. Petroleum paraffin wax, fully refined and odorless, containing at least 0.5 percent oil with a melting point of 120 to 140 deg F (49 to 60 deg C) per ASTM D 87.
  - b. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.
4. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
5. Grout Sealer: Manufacturer's standard silicone product for sealing grout joints and that does not change color or appearance of grout.

K. Mixing Mortars And Grout

1. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
2. Add materials, water, and additives in accurate proportions.
3. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

### 1.3 EXECUTION

A. Examination

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

B. Preparation

1. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with adhesives or thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
2. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot (1:50) toward drains.
3. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.



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

#### C. Tile Installation

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



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



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



- 3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
- d. Tile Installation F114: Cement mortar bed (thickset) with cleavage membrane; epoxy **OR** furan, **as directed**, grout; TCA F114 and ANSI A108.1B.
  - 1) Tile Type: as directed by the Owner.
  - 2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
  - 3) Grout: Water-cleanable epoxy **OR** Chemical-resistant furan, **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-gluе 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 185 and ASTM A 82, except for minimum wire size.
  - h. Isolation Membrane: Polyethylene sheeting, ASTM D 2103, Type 13300, 4 mils (0.1 mm) thick; or unperforated asphalt felt, ASTM D 226, Type I (No. 15).
3. Mixes:
  - a. Underbed (for structural portland cement terrazzo or portland cement terrazzo installed over metal deck): Structural-concrete underbed as specified in Division 03 Section "Cast-in-place Concrete".
  - b. Underbed (for sand-cushion or bonded portland cement terrazzo): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for component proportions and mixing.
  - c. Portland Cement Terrazzo (below for NTMA-formulated design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for matrix and marble-chip proportions and mixing.
    - 1) Formulated Mix Color and Pattern: As selected from NTMA standard-terrazzo plates **OR** As selected from NTMA Venetian-terrazzo plates, **as directed**.
  - d. Portland Cement Terrazzo (for custom design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for matrix and marble-chip **OR** aggregate, **as directed**, proportions and mixing.
    - 1) Custom Mix Color and Pattern: Match sample **OR** Match existing, **as directed**.

### B. Rustic Terrazzo

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



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



5. Expansion-Joint Strips (for structural portland cement terrazzo or for any type of rustic terrazzo): Brass **OR** Plastic strips in color selected from manufacturer's full range, **as directed**, with removable zip-strip top for installing sealant; in width indicated **OR** minimum 1/2 inch (12.7 mm) wide, **as directed**.
  6. Accessory Strips: Match divider strip width, material, and color unless otherwise indicated. Use the following types of accessory strips as required to provide a complete installation:
    - a. Base-bead strips for exposed top edge of terrazzo base.
    - b. Edge-bead strips for exposed edges of terrazzo.
    - c. Nosings for terrazzo stair treads and landings.
  7. Abrasive Strips (for terrazzo stair treads and landings): Silicon carbide or aluminum oxide, or combination of both, in epoxy-resin binder and set in channel.
    - a. Width: 1/2 inch (12.7 mm).
    - b. Depth: As required by terrazzo thickness.
    - c. Length: 4 inches (100 mm) less than stair width **OR** As indicated, **as directed**.
    - d. Color: As selected from manufacturer's full range.
- D. Miscellaneous Accessories
1. Strip Adhesive: Adhesive recommended by manufacturer for this use.
    - a. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  2. Anchoring Devices:
    - a. Strips: Provide mechanical anchoring devices for strip materials as required for secure attachment to substrate.
    - b. Precast Terrazzo: Provide mechanical anchoring devices as recommended by fabricator for proper anchorage and support of units for conditions of installation and support.
  3. Isolation and Expansion-Joint Material: Closed-cell polyethylene foam, nonabsorbent to liquid water and gas, and nonoutgassing in unruptured state; butyl rubber; rubber; or cork; in width indicated **OR** minimum 1/2 inch (12.7 mm) wide, **as directed**.
  4. Portland Cement Terrazzo Cleaner: Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by cleaner manufacturer for use on terrazzo type indicated.
  5. Rustic Terrazzo Cleaner: Solution of muriatic acid and water for use on terrazzo type indicated.
  6. Sealer: Slip- and stain-resistant, penetrating-type sealer that is chemically neutral with pH factor between 7 and 10; does not affect color or physical properties of terrazzo; is recommended by sealer manufacturer; and complies with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated.
    - a. Rustic Terrazzo: Use solvent acrylic-type sealer.
- E. Precast Terrazzo
1. Precast Terrazzo Base Units: Minimum 3/4-inch- (19-mm-) thick, reinforced portland cement terrazzo units cast in maximum lengths possible, but not less than 36 inches (900 mm).
    - a. Type: As indicated **OR** Coved with minimum 3/4-inch (19-mm) radius **OR** Straight **OR** Splayed, **as directed**.
    - b. Top Edge: Straight, unfinished if top edge is concealed **OR** Beveled with polished top surface **OR** Radius edge with polished top surface, **as directed**.
    - c. Metal Toe Strip (for coved-toe bases): Zinc **OR** Brass, **as directed**.
    - d. Outside Corner Units: With finished returned edges at outside corner.
    - e. Color, Pattern, and Finish: As selected from manufacturer's full range **OR** Match sample **OR** Match adjacent poured-in-place terrazzo flooring, **as directed**.
  2. Precast Terrazzo Units for Stair Treads, Thresholds, Sills, Benches and Planters: Comply with NTMA's written recommendations for fabricating precast terrazzo units in sizes and profiles indicated. Reinforce units as required by unit sizes, profiles, and thicknesses and as recommended by manufacturer.
    - a. Stair Treads: Three-line **OR** Two-line **OR** One-line **OR** Abrasive nosing strip and two-line, **as directed**, abrasive inserts at nosings.



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

### 1.3 EXECUTION

#### A. Preparation

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

#### B. Installation, General

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



- c. Accessory Strips: Install accessory strips as required to provide a complete installation.
  - d. Abrasive Strips: Install with surface of abrasive strip positioned 1/16 inch (1.6 mm) **OR** 1/32 inch (0.8 mm), **as directed**, higher than terrazzo surface.
7. Repair: Cut out and replace terrazzo areas that evidence lack of bond with substrate or underbed, including areas that emit a "hollow" sound if tapped. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA's written recommendations, as approved by the Owner.

C. Portland Cement Terrazzo Installation

1. Pour in place, cure, and finish portland cement terrazzo according to NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated.
2. Terrazzo Topping Thickness: As indicated.
3. Finishing:
  - a. Seed additional marble chips **OR** aggregates, **as directed**, in matrix to uniformly distribute granular material on surface.
  - b. Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted.
  - c. Fine Grinding: Grind with stones 120 grit or finer until all grout is removed from surface. Repeat rough grinding, grout coat, and fine grinding if large voids exist after initial fine grinding. Produce surface with a minimum of 70 percent aggregate exposure.

D. Rustic Terrazzo Installation

1. Pour in place, cure, and finish rustic terrazzo according to NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated.
2. Terrazzo Topping Thickness: As indicated.
3. Finishing:
  - a. Seed additional marble chips **OR** aggregates, **as directed**, in matrix to uniformly distribute granular material on surface.

E. Precast Terrazzo Installation

1. Install precast terrazzo units using method recommended by NTMA and manufacturer unless otherwise indicated.
2. Installation Tolerance: Set units with alignment level and true to dimensions, varying 1/8 inch (3.2 mm) maximum in length, height, or width; noncumulative.
3. Do not install units that are chipped, cracked, discolored, or improperly finished.
4. Seal joints between units with cement grout matching precast terrazzo matrix **OR** joint sealant, **as directed**.

F. Cleaning And Protection

1. Portland Cement Terrazzo and Precast Terrazzo Cleaning:
  - a. Remove grinding dust from installation and adjacent areas.
  - b. Wash surfaces with cleaner immediately after grouting precast terrazzo units and final cleaning of terrazzo flooring.
  - c. Wash surfaces with cleaner according to NTMA's written recommendations and manufacturer's written instructions; rinse surfaces with water and allow to dry thoroughly.
2. Rustic Terrazzo Cleaning: Clean surfaces with 1:10 solution of muriatic acid in water. Legally contain and dispose of runoff from cleaning operations. Rinse surfaces with water and allow to dry thoroughly.
3. Sealing:
  - a. Seal surfaces according to NTMA's written recommendations.
  - b. Apply sealer according to sealer manufacturer's written instructions.
4. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that terrazzo is without damage or deterioration at time of Final Completion.



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END OF SECTION 09 01 60 91



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**SECTION 09 01 60 91a - 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**.



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END OF SECTION 09 01 60 91a

**SECTION 09 01 60 91b - 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, 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 01 60 91b



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
09 01 60 91	01 22 16 00	No Specification Required
09 01 60 91	07 91 23 00	Joint Sealants
09 05 71 00	09 01 30 91	Ceramic Tile



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## SECTION 09 22 13 00 - GYPSUM PLASTER

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. Section Includes:
  - a. Gypsum plasterwork on expanded-metal lath, unit masonry and monolithic concrete.
  - b. Solid-plaster partitions.

#### C. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
  - a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
    - 1) Include statement indicating costs for each product having recycled content.
  - b. Product Data for Credit EQ 4.1: For sealants, including printed statement of VOC content.
3. Shop Drawings: Show locations and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other work.

#### D. Quality Assurance

1. Fire-Resistance Ratings: Where indicated, provide gypsum plaster assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - a. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
2. Sound Transmission Characteristics: Where indicated, provide gypsum plaster assemblies identical to those of assemblies tested for STC ratings per ASTM E 90 and classified according to ASTM E 413 by a qualified testing agency.

#### E. Delivery, Storage, And Handling

1. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

#### F. Project Conditions

1. Comply with ASTM C 842 requirements or gypsum plaster manufacturer's written recommendations, whichever are more stringent.
2. Room Temperatures: Maintain temperatures at not less than 55 deg F (13 deg C) or greater than 80 deg F (27 deg C) for at least seven days before application of gypsum plaster, continuously during application, and for seven days after plaster has set or until plaster has dried.
3. Avoid conditions that result in gypsum plaster drying out too quickly.
  - a. Distribute heat evenly; prevent concentrated or uneven heat on plaster.
  - b. Maintain relative humidity levels for prevailing ambient temperature that produce normal drying conditions.
  - c. Ventilate building spaces in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.



## 1.2 PRODUCTS

### A. Steel Framing For Solid-Plaster Partitions

1. Components, General: Comply with ASTM C 841. For steel sheet components not included in ASTM C 841, comply with ASTM C 645 requirements for metal unless otherwise indicated.
2. Channel Studs: Cold-rolled channels, 3/4 inch (19.1 mm) **OR** 1-1/2 inches (38.1 mm), **as directed**, deep.
3. Runners: L-runners with perforated or plain legs to suit lath attachment requirements, in 0.033-inch (0.84-mm) base-metal thickness where attached to overhead support and in 0.043-inch (1.1-mm) base-metal thickness where attached to floor.

### B. Expanded-Metal Lath

1. Expanded-Metal Lath: ASTM C 847, cold-rolled carbon-steel sheet, ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coated.
  - a. Recycled Content: Provide steel products with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
  - b. Paper Backing: Kraft paper factory bonded to back of lath.
  - c. Diamond-Mesh Lath: Flat **OR** Self-furring, **as directed**, 2.5 lb/sq. yd. (1.4 kg/sq. m) **OR** 3.4 lb/sq. yd. (1.8 kg/sq. m), **as directed**.
  - d. Flat Rib Lath: Rib depth of not more than 1/8 inch (3.1 mm), 2.75 lb/sq. yd. (1.5 kg/sq. m) **OR** 3.4 lb/sq. yd. (1.8 kg/sq. m), **as directed**.
  - e. 3/8-Inch (9.5-mm) Rib Lath: 3.4 lb/sq. yd. (1.8 kg/sq. m) **OR** 4 lb/sq. yd. (2.2 kg/sq. m), **as directed**.

### C. Accessories

1. General: Comply with ASTM C 841 and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
2. Metal Accessories:
  - a. Cornerite: Fabricated from expanded-metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
  - b. Striplath: Fabricated from expanded-metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
  - c. Cornerbeads: Fabricated from zinc or zinc-coated (galvanized) steel.
    - 1) Small nose cornerbead with expanded flanges; use unless otherwise indicated.
    - 2) Small nose cornerbead with perforated flanges; use on curved corners.
    - 3) Small nose cornerbead with expanded flanges reinforced by perforated stiffening rib; use on columns and for finishing unit masonry corners.
    - 4) Bull nose cornerbead, radius 3/4 inch (19.1 mm) minimum, with expanded flanges; use at locations indicated on Drawings.
  - d. Casing Beads: Fabricated from zinc or zinc-coated (galvanized) steel; square-edged style; with expanded flanges.
  - e. Control Joints: Fabricated from zinc or zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
  - f. Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
  - g. Two-Piece Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4 to 5/8 inch (6 to 16 mm) wide; with perforated flanges.
3. Plastic Accessories: Fabricated from high-impact PVC.
  - a. Cornerbeads: With perforated flanges.
    - 1) Small nose cornerbead; use unless otherwise indicated.
    - 2) Bull nose cornerbead, radius 3/4 inch (19.1 mm) minimum; use at locations indicated on Drawings.



- b. Casing Beads: With perforated flanges in depth required to suit plaster bases indicated and flange length required to suit applications indicated.
    - 1) Square-edge style; use unless otherwise indicated.
    - 2) Bull-nose style, radius 3/4 inch (19.1 mm) minimum; use at locations indicated on Drawings.
  - c. Control Joints: One-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
  - d. Expansion Joints: Two-piece type, formed to produce slip-joint and square-edged 1/2-inch- (13-mm-) **OR** 1-inch- (25.4-mm-) **OR** 1-1/2-inch- (38.1-mm-), **as directed**, wide reveal; with perforated concealed flanges.
4. Aluminum Trim: Extruded accessories of profiles and dimensions indicated on Drawings.
- a. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
  - b. Finish: Mill **OR** Chemical-conversion coating, ASTM D 1730, Type B, compatible with field-applied finish coatings specified, **as directed**.
- D. Miscellaneous Materials
1. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
  2. Bonding Compound: ASTM C 631.
  3. Steel Drill Screws: For metal-to-metal fastening, ASTM C 1002 or ASTM C 954, as required by thickness of metal being fastened; with pan head that is suitable for application; in lengths required to achieve penetration through joined materials of no fewer than three exposed threads.
  4. Fasteners for Attaching Metal Lath to Substrates: Complying with ASTM C 841.
  5. Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch (1.21-mm) diameter, unless otherwise indicated.
  6. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
    - a. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of rated assembly.
    - b. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
  7. Acoustical Sealant: As specified in Division 7 Section "Joint Sealants."
    - a. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Base-Coat Plaster Materials
1. Base-Coat Plasters, General: ASTM C 28/C 28M.
  2. Lightweight Gypsum Ready-Mixed Plaster: With mill-mixed perlite aggregate.
  3. Gypsum Neat Plaster: For use with job-mixed aggregates.
  4. Gypsum Wood-Fibered Plaster:
  5. High-Strength Gypsum Neat Plaster: With a minimum, average, dry compressive strength of 2800 psi (19 MPa) per ASTM C 472 for a mix of 100 lb (45 kg) of plaster and 2 cu. ft. (0.06 cu. m) of sand.
  6. Aggregates for Base-Coat Plasters: ASTM C 35, sand and perlite.
- F. Finish-Coat Plaster Materials
1. Gypsum Gaging Plaster: ASTM C 28/C 28M.
  2. Gypsum Ready-Mixed Finish Plaster: Manufacturer's standard, mill-mixed, gaged, interior finish.
  3. High-Strength Gypsum Gaging Plaster: ASTM C 28/C 28M, with a minimum, average, dry compressive strength of 5000 psi (34 MPa) per ASTM C 472 for a neat mix.
  4. Gypsum Keene's Cement: ASTM C 61/C 61M.
  5. Lime: ASTM C 206, Type S, special finishing hydrated lime.



6. Lime: ASTM C 206, Type N, normal finishing hydrated lime.
7. Aggregates for Float Finishes: ASTM C 35, sand **OR** perlite, **as directed**; graded per ASTM C 842.

G. Plaster Mixes

1. Mixing: Comply with ASTM C 842 and manufacturer's written instructions for applications indicated.

### 1.3 EXECUTION

A. Examination

1. Examine nonstructural and structural metal framing, substrates, and hollow-metal frames, for compliance with requirements and other conditions affecting performance of the Work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation

1. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.

C. Installation, General

1. Fire-Resistance-Rated Assemblies: Install components according to requirements for design designations from listing organization and publication indicated on Drawings.
2. STC-Rated Assemblies: Install components according to requirements for design designations from listing organization and publication indicated on Drawings.
  - a. Seal construction at perimeters, behind control and expansion joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations.
  - b. Comply with ASTM C 919 and manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
3. Sound Attenuation Blankets: Where required, install blankets before installing lath unless blankets are readily installed after lath has been installed on one side.
4. Acoustical Sealant: Where required, seal joints between edges of plasterwork and abutting construction with acoustical sealant.

D. Installing Steel Framing For Solid-Plaster Partitions

1. Install according to ASTM C 841.
2. Framing for Solid-Plaster Partitions: Provide channel stud to support expanded-metal lath construction.
  - a. Space channel studs at 16 inches (406 mm) **OR** 24 inches (610 mm), **as directed**, o.c. unless otherwise indicated.
3. Framing for Studless Solid-Plaster Partition: Provide top and bottom L-track runners to support expanded-metal lath.

E. Installing Expanded-Metal Lath

1. Expanded-Metal Lath: Install according to ASTM C 841.
  - a. Partition Framing and Vertical Furring: Install flat diamond-mesh **OR** flat rib, **as directed**, lath.
  - b. Flat-Ceiling and Horizontal Framing: Install flat diamond-mesh **OR** flat rib, **as directed**, lath.
  - c. Curved-Ceiling Framing: Install flat diamond-mesh lath.
  - d. On Solid Surfaces, Not Otherwise Furred: Install self-furring, diamond-mesh lath.
  - e. Solid-Plaster Partitions: Where supported by channel studs, install flat rib **OR** flat diamond-mesh, **as directed**, lath.



- f. Studless Solid-Plaster Partitions: Install 3/8-inch (9.5-mm) rib lath.

F. Installing Accessories

1. General: Install according to ASTM C 841.
2. Cornerbeads: Install at external corners.
3. Casing Beads: Install at terminations of plasterwork, except where plaster passes behind and is concealed by other work and where metal screeds, bases, or frames act as casing beads.
4. Control Joints: Install control joints at locations indicated on Drawings **OR** with spacing between joints in either direction not exceeding the following and in specific locations approved by Architect for visual effect, **as directed**:
  - a. Partitions: 30 feet (9 m).
  - b. Ceilings: 50 feet (15 m) **OR** 30 feet (9 m), **as directed**.

G. Plaster Application

1. General: Comply with ASTM C 842.
  - a. Do not deviate more than plus or minus 1/8 inch in 10 feet (3.1 mm in 3 m) from a true plane in finished plaster surfaces, as measured by a 10-foot (3-m) straightedge placed on surface.
  - b. Grout hollow-metal frames, bases, and similar work occurring in plastered areas, with base-coat plaster material, before lathing where necessary. Except where full grouting is indicated or required for fire-resistance rating, grout at least 6 inches (152 mm) at each jamb anchor.
  - c. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
  - d. Provide plaster surfaces that are ready to receive field-applied finishes indicated.
2. Bonding Compound: Apply on unit masonry and concrete plaster bases.
3. Base Coats:
  - a. Base Coats over Expanded-Metal Lath: High-strength gypsum **OR** Gypsum neat, **as directed**, plaster with job-mixed sand for scratch and brown coats.
  - b. Base Coats over Expanded-Metal Lath:
    - 1) Scratch Coat: Gypsum wood-fibered plaster; neat or with job-mixed sand.
    - 2) Brown Coat: Gypsum wood-fibered plaster with job-mixed sand **OR** neat plaster with job-mixed sand **OR** lightweight ready-mixed plaster **OR** neat plaster with job-mixed perlite, **as directed**.
  - c. Base Coats over Unit Masonry: Gypsum wood-fibered plaster with job-mixed sand **OR** neat plaster with job-mixed sand **OR** lightweight ready-mixed plaster, **as directed**.
  - d. Base-Coat Mix over Monolithic Concrete: Gypsum neat plaster with job-mixed sand.
4. Finish Coats:
  - a. Finish-Coat Mix for Smooth-Troweled Finishes: Gypsum gaging plaster **OR** Gypsum ready-mixed finish plaster **OR** High-strength gypsum gaging plaster **OR** Gypsum Keene's cement, **as directed**.
  - b. Finish-Coat Mix for Float Finishes: Gypsum gaging plaster **OR** Gypsum Keene's cement, **as directed**.
  - c. Finish-Coat Mix for Sprayed Finishes: Gypsum ready-mixed finish plaster.
  - d. Finish-Coat Mix for Textured Finishes: Gypsum ready-mixed finish plaster.
5. Plaster Finishes:
  - a. Provide troweled finish unless otherwise indicated **OR** where indicated, **as directed**.
  - b. Provide float finish unless otherwise indicated **OR** where indicated, **as directed**.
  - c. Provide sprayed finish unless otherwise indicated **OR** where indicated, **as directed**.
    - 1) Sprayed Finish: Match sample.
  - d. Provide textured finish where indicated.
    - 1) Textured Finish: Match sample.
6. Concealed Plaster:



- 
- a. Where plaster application will be concealed behind built-in cabinets, similar furnishings, and equipment, apply finish coat.
  - b. Where plaster application will be concealed above suspended ceilings and in similar locations, finish coat may be omitted.
  - c. Where plaster application will be used as a base for adhesive application of tile and similar finishes, finish coat may be omitted.

H. Plaster Repairs

- 1. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

I. Cleaning And Protection

- 1. Remove temporary protection and enclosure of other work. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 09 22 13 00



## SECTION 09 22 13 00a - GYPSUM VENEER PLASTER

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. This Section includes the following:
  - a. Gypsum veneer plaster and gypsum base for veneer plaster.
  - b. Gypsum veneer plaster over cementitious backer units.
  - c. Gypsum veneer plaster over masonry surfaces.
  - d. Gypsum veneer plaster over monolithic concrete surfaces.

#### C. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: Show locations, fabrication, and installation of control joints, and reveals and trim; include plans, elevations, sections, details of components, and attachments to other work.
3. Samples: For the following products:
  - a. Trim Accessories: Full-size Sample in 12-inch (300-mm) length for each trim accessory.
  - b. Textured Finishes: Manufacturer's standard size for each textured finish and on rigid backing.
4. LEED Submittals:
  - a. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
  - b. Product Data for Credit MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
    - 1) Include statement indicating costs for each product having recycled content.

#### D. Quality Assurance

1. Source Limitations: Obtain gypsum veneer plaster products, including gypsum base for veneer plaster, **OR** cementitious base units, **as directed**, joint reinforcing tape, and embedding material, from a single manufacturer.
2. Fire-Resistance-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by a testing and inspecting agency.
3. STC-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.

#### E. Delivery, Storage, And Handling

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

#### F. Project Conditions

1. Environmental Limitations: Comply with ASTM C 843 requirements or gypsum veneer plaster manufacturer's written recommendations, whichever are more stringent.



2. Room Temperatures: Maintain not less than 55 deg F (13 deg C) or more than 80 deg F (27 deg C) for 7 days before application of gypsum base and gypsum veneer plaster, continuously during application, and after application until veneer plaster is dry.
3. Avoid conditions that result in gypsum veneer plaster drying too rapidly.
  - a. Distribute heat evenly; prevent concentrated or uneven heat on veneer plaster.
  - b. Maintain relative humidity levels, for prevailing ambient temperature, that produce normal drying conditions.
  - c. Ventilate building spaces in a manner that prevents drafts of air from contacting surfaces during veneer plaster application until it is dry.
4. Do not install panels that are wet, moisture damaged, or mold damaged.
  - a. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
  - b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

## 1.2 PRODUCTS

### A. Gypsum Veneer Plaster Materials

1. One-Component Gypsum Veneer Plaster: ASTM C 587, formulated for application directly over substrate without use of separate base-coat material.
2. High-Strength, One-Component Gypsum Veneer Plaster: ASTM C 587, ready-mixed, smooth, finish-coat veneer plaster containing mill-mixed, fine silica sand; with a compressive strength of 3000 psi (20 MPa) when tested according to ASTM C 472; and formulated for application directly over substrate without use of separate base-coat material.
3. Two-Component Gypsum Veneer Plaster: ASTM C 587, with separate formulations; one for base-coat and one for finish-coat application over substrates.
4. High-Strength, Two-Component Gypsum Veneer Plaster: ASTM C 587, ready-mixed, base-coat plaster and smooth finish-coat veneer plaster containing mill-mixed, fine silica sand; with a compressive strength of 3000 psi (20 MPa) when tested according to ASTM C 472.
5. Radiant-Heat, Two-Component Gypsum Veneer Plaster: ASTM C 587, and approved in writing by gypsum veneer plaster manufacturer for application with embedded electric heating cables.
  - a. Provide ready-mixed **OR** job-aggregated, **as directed**, components, as standard for manufacturer, to comply with manufacturer's written recommendations.
  - b. Aggregate: For job-aggregated base coat and texture finish coat, provide white silica sand passing a No. 30 (0.6-mm) sieve.

### B. Panel Products

1. Recycled Content: Provide gypsum panel products with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
2. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.
3. Gypsum Base for Veneer Plaster: ASTM C 588/C 588M.
  - a. Regular Type: In thickness indicated **OR** 1/2 inch (13 mm) thick, unless otherwise indicated, **as directed**.
  - b. Type X: In thickness indicated **OR** 5/8 inch (16 mm) thick, **as directed**.
  - c. Foil-Backed, Regular-Type Core: In thickness indicated **OR** 1/2 inch (13 mm) thick, unless otherwise indicated, **as directed**.
  - d. Type C: In thickness indicated **OR** 5/8 inch (16 mm) thick **OR** 1/2 inch (13 mm) thick, **as directed**.
  - e. Abuse-Resistant Base: With specially reinforced core for greater resistance to surface indentation, 5/8-inch (16-mm) thick, Type X core **OR** 1/2-inch (13-mm) thick, regular-type core, **as directed**.



- f. High-Impact Base: With Type X core, plastic film laminated to back side for greater resistance to through-penetration (impact resistance), and in thickness indicated **OR** 5/8 inch (16 mm) thick, **as directed**.
    - 1) Plastic-Film Thickness: 0.010 inch (0.254 mm) **OR** 0.020 inch (0.508 mm) **OR** 0.030 inch (0.762 mm) **OR** 0.081 inch (2.057 mm), **as directed**.
  - g. Moisture- and Mold-Resistant Base: With moisture- and mold-resistant core, glass-mat facing on both sides of panel, and in thickness indicated **OR** 5/8-inch (16-mm) thick, Type X core **OR** 1/2-inch (13-mm) thick, regular-type core, **as directed**.
    - 1) Mold Resistance: ASTM D 3273; no mold growth after four weeks' exposure.
  4. Backing Panels for Multilayer Applications: ASTM C 588/C 588M gypsum base or ASTM C 36/C 36M gypsum board, as recommended by gypsum veneer plaster manufacturer, for application method and thicknesses indicated.
    - a. Core: Matching face layer, unless otherwise indicated.
    - b. Thickness: Matching face layer, unless otherwise indicated.
  5. Cementitious Backer Units: ANSI A118.9, in thickness indicated **OR** 1/2 inch (13 mm) thick, **as directed**.
- C. Trim Accessories
1. Standard Trim: ASTM C 1047, provided or approved by manufacturer for use in gypsum veneer plaster applications indicated.
    - a. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet **OR** Galvanized or aluminum-coated steel sheet or rolled zinc **OR** Plastic **OR** Paper-faced galvanized steel sheet, **as directed**.
    - b. Shapes:
      - 1) Cornerbead.
      - 2) Bullnose bead.
      - 3) LC-Bead: J-shaped; exposed long flange receives joint compound.
      - 4) L-Bead: L-shaped; exposed long flange receives joint compound.
      - 5) U-Bead: J-shaped; exposed short flange does not receive joint compound.
      - 6) Curved-Edge Cornerbead: With notched or flexible flanges.
      - 7) Control joints.
  2. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
    - a. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
    - b. Finish: Manufacturer's standard Architectural Class II, Clear Anodic Finish AA-M12C22A31, complying with AAMA 611 **OR** chemical conversion coat finish **OR** prime paint finish, **as directed**.
- D. Joint Reinforcing Materials
1. General: Comply with joint strength requirements in ASTM C 587 and with gypsum veneer plaster manufacturer's written recommendations for each application indicated.
  2. Joint Tape:
    - a. Gypsum Base for Veneer Plaster: As recommended by gypsum veneer plaster manufacturer for applications indicated **OR** Paper **OR** Open-mesh, glass fiber, **as directed**.
    - b. Cementitious Backer Units: As recommended by cementitious backer unit manufacturer.
  3. Embedding Material for Joint Tape:
    - a. Gypsum Base for Veneer Plaster: As recommended by gypsum veneer plaster manufacturer for use with joint-tape material and gypsum veneer plaster applications indicated.
    - b. Cementitious Backer Units: As recommended by cementitious backer unit manufacturer for applications indicated.
- E. Auxiliary Materials
1. General: Provide auxiliary materials that comply with referenced product standards and manufacturer's written recommendations.



2. Bonding Agent: ASTM C 631, polyvinyl acetate.
3. Laminating Adhesive: Adhesive or joint compound recommended by manufacturer for directly adhering gypsum base face-layer panels to backing-layer panels in multilayer construction.
  - a. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
  - a. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
5. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
6. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing), produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
  - a. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
  - b. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
7. Acoustical Sealant: As specified in Division 07 Section "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).
8. Patching Mortar: Dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.

#### F. Gypsum Veneer Plaster Mixes

1. Mechanically mix gypsum veneer plaster materials to comply with ASTM C 843 and with gypsum veneer plaster manufacturer's written recommendations.

### 1.3 EXECUTION

#### A. Preparation

1. Monolithic Concrete Substrates: Prepare according to gypsum veneer plaster manufacturer's written recommendations and as follows:
  - a. Clean surfaces to remove dust, loose particles, grease, oil, incompatible curing compounds, form-release agents, and other foreign matter and deposits that could impair bond with gypsum veneer plaster.
  - b. Remove ridges and protrusions greater than 1/8 inch (3 mm) and fill depressions greater than 1/4 inch (6 mm) with patching mortar. Allow to set and dry.
  - c. Apply bonding agent on dry and cured concrete substrates.
2. Masonry Substrates: Prepare according to gypsum veneer plaster manufacturer's written recommendations and as follows:
  - a. Clean surfaces to remove dirt, grease, oil, and other foreign matter and deposits that could impair bond with gypsum veneer plaster.
  - b. Apply bonding agent on dry masonry substrates.

#### B. Installing Panels, General

1. Gypsum Base for Veneer Plaster: Apply according to ASTM C 844 unless manufacturer's written recommendations are more stringent.
  - a. Do not allow gypsum base to degrade from exposure to sunlight as evidenced by fading of paper facing.
  - b. Erection Tolerance: No more than 1/16-inch (1.6-mm) offsets between planes of gypsum base panels, and 1/8 inch in 8 feet (3 mm in 2.4 m) noncumulative, for level, plumb, warp, and bow.



2. Install sound attenuation blankets before installing gypsum base for veneer plaster unless blankets are readily installed after panels have been installed on one side.
3. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
4. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.6 mm) of open space between panels. Do not force into place.
5. Locate edge and end joints over supports except in ceiling applications where intermediate supports or back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints, other than control joints, at corners of framed openings.
6. Attach panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
7. Attach panels to framing provided at openings and cutouts.
8. Form control joints with space between edges of adjoining panels.
9. Cover both sides of steel stud partition framing with panels in concealed spaces, including above ceilings, except in internally braced chases.
  - a. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.74 sq. m) in area.
  - b. Fit panels around ducts, pipes, and conduits.
  - c. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints; seal joints with acoustical sealant.
10. Wood Framing: Install panels over wood framing, with "floating" internal corner construction. Do not attach panels across the flat grain of wide-dimension lumber, including floor joists and headers. "Float" panels over these members or provide control joints to counteract wood shrinkage.
11. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
12. Fastener Spacing: Comply with ASTM C 844, manufacturer's written recommendations, and fire-resistance-rating requirements.
  - a. Space screws a maximum of 12 inches (305 mm) o.c. along framing members for wall or ceiling application.
  - b. Space fasteners in cementitious backer units a maximum of 8 inches (200 mm) o.c. along framing members for wall applications and 6 inches (150 mm) o.c. along framing members for ceiling applications.

#### C. Installing Panels

1. Install gypsum base panels for veneer plaster in the following locations:
  - a. Regular Type: As indicated on Drawings **OR** Vertical surfaces, unless otherwise indicated, **as directed**.
  - b. Ceiling Type: As indicated on Drawings **OR** Ceiling surfaces, **as directed**.
  - c. Type X: As indicated on Drawings **OR** Where required for fire-resistance-rated assembly **OR** Vertical surfaces, unless otherwise indicated, **as directed**.
  - d. Type C: As indicated on Drawings **OR** Where required for specific fire-resistance-rated assembly indicated, **as directed**.
  - e. Foil-Backed, Regular-Type Core: As indicated on Drawings **OR as directed**.
  - f. Abuse-Resistant Base: As indicated on Drawings **OR as directed**.
  - g. High-Impact Base: As indicated on Drawings **OR as directed**.
  - h. Moisture- and Mold-Resistant Base: As indicated on Drawings **OR as directed**.
2. Single-Layer Application:



- a. On ceilings, apply gypsum base panels before wall panels, to the greatest extent possible and at right angles to framing, unless otherwise indicated.
  - b. On walls, apply gypsum base panels vertically and parallel **OR** horizontally and perpendicular, **as directed**, to framing, unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
    - 1) Stagger abutting end joints not less than one framing member in alternate courses of panels.
    - 2) At stairwells and other walls higher than 30 feet (9.0 m), install gypsum base panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
  - c. On Z-furring, apply gypsum base panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
3. Multilayer Application on Ceilings: Apply backing panels for ceilings before applying backing panels for partitions; apply gypsum-base face layers in same sequence. Apply backing panels at right angles to framing members and offset gypsum-base face-layer joints a minimum of 16 inches (400 mm) from parallel backing panel joints, unless otherwise required by fire-resistance-rated assembly.
  4. Multilayer Application on Partitions: Apply backing panels indicated and gypsum-base face layers vertically (parallel to framing) with joints of backing panels located over stud or furring members and gypsum-base face-layer joints offset at least one stud or furring member from backing-panel joints, unless otherwise required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
    - a. Z-Furring: Apply backing panels vertically (parallel to framing) and gypsum-base face layer either vertically or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of backing panels over furring members.
  5. Single-Layer Fastening Methods: Apply gypsum base panels to supports with steel drill screws.
  6. Multilayer Fastening Methods: Fasten backing panels and gypsum-base face layers separately to supports with screws **OR** with screws; fasten gypsum-base face layers with adhesive and supplementary fasteners, **as directed**.
  7. Curved Partitions: Comply with gypsum base manufacturer's written installation recommendations.
  8. Cementitious Backer Units: Install according to ANSI A108.11.
    - a. Where cementitious backer units abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.
- D. Installing Trim Accessories
1. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
  2. Control Joints: Install at locations indicated on Drawings **OR** according to ASTM C 844 and in specific locations approved by the Owner, **as directed**.
  3. Trim: Install in the following locations:
    - a. Cornerbead: Use at outside corners, unless otherwise indicated.
    - b. Bullnose Bead: Use at outside corners **OR** where indicated, **as directed**.
    - c. LC-Bead: Use at exposed panel edges.
    - d. L-Bead: Use where indicated.
    - e. U-Bead: Use at exposed panel edges **OR** where indicated, **as directed**.
    - f. Curved-Edge Cornerbead: Use at curved openings.
  4. Aluminum Trim:
    - a. Install aluminum trim according to manufacturer's written recommendations.
    - b. Apply and embed joint tape over flanges of aluminum trim accessories if recommended by trim manufacturer.
- E. Installing Joint Reinforcement



1. Gypsum Base for Veneer Plaster: Reinforce interior angles and flat joints with joint tape and embedding material to comply with ASTM C 843 and with gypsum veneer plaster manufacturer's written recommendations.
  2. Abuse-Resistant Base: Reinforce joints between abuse-resistant panels with joint tape and embedding material according to panel manufacturer's written recommendations.
  3. Impact-Resistant Base: Reinforce joints between impact-resistant panels with joint tape and embedding material according to panel manufacturer's written recommendations.
  4. Moisture- and Mold-Resistant Base: Reinforce joints between moisture- and mold-resistant panels with joint tape and embedding material according to panel manufacturer's written recommendations.
  5. Cementitious Backer Units: Reinforce joints between cementitious backer units with joint tape and embedding material according to unit manufacturer's written recommendations.
- F. Gypsum Veneer Plastering
1. Bonding Agent: Apply bonding agent on dry monolithic concrete **OR** masonry **OR** abuse-resistant base panels **OR** cementitious backer units, **as directed**, according to gypsum veneer plaster manufacturer's written recommendations.
  2. Gypsum Veneer Plaster Application: Comply with ASTM C 843 and with veneer plaster manufacturer's written recommendations.
    - a. One-Component Gypsum Veneer Plaster: Trowel apply base coat over substrate to uniform thickness of 1/16 to 3/32 inch (1.6 to 2.4 mm). Fill all voids and imperfections. Allow plaster to set, then scratch and immediately double back with gypsum veneer plaster to uniform total thickness of 3/16 inch (4.8 mm).
    - b. Two-Component Gypsum Veneer Plaster:
      - 1) Base Coat: Trowel apply base coat over substrate to uniform thickness of 1/16 to 3/32 inch (1.6 to 2.4 mm). Fill all voids and imperfections.
      - 2) Finish Coat: Trowel apply finish-coat plaster over base-coat plaster to uniform thickness of 1/16 to 3/32 inch (1.6 to 2.4 mm).
    - c. Where gypsum veneer plaster abuts only metal door frames, windows, and other units, groove finish coat to eliminate spalling.
    - d. Do not apply veneer plaster to gypsum base if paper facing has degraded from exposure to sunlight. Before applying veneer plaster, use remedial methods to restore bonding capability to degraded paper facing according to manufacturer's written recommendations and as approved by the Owner.
  3. Radiant-Heat, Two-Component Gypsum Veneer Plaster Ceilings: Comply with ASTM C 843 and with radiant-heat veneer plaster manufacturer's written recommendations.
    - a. Base Coat: Apply plaster base coat to sufficiently cover electric heating cables. Trowel plaster parallel in direction of cables to uniform thickness of 3/16 inch (4.8 mm). Completely cover cables.
    - b. Finish Coat: After base coat has developed sufficient bond, apply finish coat. Trowel plaster to uniform thickness of 1/16 to 3/32 inch (1.6 to 2.4 mm).
  4. Concealed Surfaces: Do not omit gypsum veneer plaster behind cabinets, furniture, furnishings, and similar removable items. Omit veneer plaster in the following areas where it will be concealed from view in the completed Work unless otherwise indicated or required to maintain fire-resistance and STC ratings:
    - a. Above suspended ceilings.
    - b. Behind wood paneling.
  5. Gypsum Veneer Plaster Finish: Smooth-troweled finish, unless otherwise indicated **OR** Textured finish matching the Owner's sample, **as directed**.
- G. Protection
1. Protect installed gypsum veneer plaster from damage from weather, condensation, construction, and other causes during remainder of the construction period.
  2. Remove and replace gypsum veneer plaster and gypsum base panels that are wet, moisture damaged, or mold damaged.



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- a. Indications that gypsum base panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
  - b. Indications that gypsum base panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 22 13 00a



## SECTION 09 22 13 00b - PORTLAND CEMENT PLASTER

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. Section Includes:
  - a. Interior portland cement plasterwork on metal lath, unit masonry and monolithic concrete.
  - b. Exterior portland cement plasterwork (stucco) on metal lath, unit masonry and monolithic concrete.

#### C. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
  - a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
    - 1) Include statement indicating costs for each product having recycled content.
  - b. Product Data for Credit EQ 4.1: For sealants, including printed statement of VOC content.
3. Shop Drawings: Show locations and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other work.
4. Samples: For each type of factory-prepared, colored or textured finish coat indicated; 12 by 12 inches (305 by 305 mm), and prepared on rigid backing.

#### D. Quality Assurance

1. Fire-Resistance Ratings: Where indicated, provide portland cement plaster assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - a. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
2. Sound-Transmission Characteristics: Where indicated, provide portland cement plaster assemblies identical to those of assemblies tested for STC ratings per ASTM E 90 and classified according to ASTM E 413 by a qualified testing agency.
3. Preinstallation Conference: Conduct conference at Project site.

#### E. Delivery, Storage, And Handling

1. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

#### F. Project Conditions

1. Comply with ASTM C 926 requirements.
2. Interior Plasterwork: Maintain room temperatures at greater than 40 deg F (4.4 deg C) for at least 48 hours before plaster application, and continuously during and after application.
  - a. Avoid conditions that result in plaster drying out during curing period. Distribute heat evenly; prevent concentrated or uneven heat on plaster.
  - b. Ventilate building spaces as required to remove water in excess of that required for hydrating plaster in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.
3. Exterior Plasterwork:



- a. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
- b. Apply plaster when ambient temperature is greater than 40 deg F (4.4 deg C).
- c. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.
4. Factory-Prepared Finishes: Comply with manufacturer's written recommendations for environmental conditions for applying finishes.

## 1.2 PRODUCTS

### A. Metal Lath

1. Expanded-Metal Lath: ASTM C 847 with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
  - a. Recycled Content: Provide steel products with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
  - b. Diamond-Mesh Lath: Flat **OR** Self-furring, **as directed**, 2.5 lb/sq. yd. (1.4 kg/sq. m) **OR** 3.4 lb/sq. yd. (1.8 kg/sq. m), **as directed**.
  - c. Flat Rib Lath: Rib depth of not more than 1/8 inch (3.1 mm), 2.75 lb/sq. yd. (1.5 kg/sq. m) **OR** 3.4 lb/sq. yd. (1.8 kg/sq. m), **as directed**.
  - d. 3/8-Inch (9.5-mm) Rib Lath: 3.4 lb/sq. yd. (1.8 kg/sq. m) **OR** 4 lb/sq. yd. (2.2 kg/sq. m), **as directed**.
2. Wire-Fabric Lath:
  - a. Welded-Wire Lath: ASTM C 933; self-furring, 1.4 lb/sq. yd. (0.8 kg/sq. m) **OR** 1.95 lb/sq. yd. (1.1 kg/sq. m), **as directed**.
  - b. Woven-Wire Lath: ASTM C 1032; self-furring, with stiffener wire backing, 1.1 lb/sq. yd. (0.6 kg/sq. m) **OR** 1.4 lb/sq. yd. (0.8 kg/sq. m), **as directed**.
3. Paper Backing: FS UU-B-790, Type I, Grade D, Style 2 vapor-permeable paper **OR** Grade B, Style 1a vapor-retardant paper, **as directed**.
  - a. Provide paper-backed lath unless otherwise indicated **OR** at exterior locations **OR** in locations indicated on Drawings, **as directed**.

### B. Accessories

1. General: Comply with ASTM C 1063 and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
2. Metal Accessories:
  - a. Foundation Weep Screed: Fabricated from hot-dip galvanized-steel sheet, ASTM A 653/A 653M, G60 (Z180) zinc coating.
  - b. Cornerite: Fabricated from metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
  - c. External-Corner Reinforcement: Fabricated from metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
  - d. Cornerbeads: Fabricated from zinc or zinc-coated (galvanized) steel.
    - 1) Small nose cornerbead with expanded flanges; use unless otherwise indicated.
    - 2) Small nose cornerbead with perforated flanges; use on curved corners.
    - 3) Small nose cornerbead with expanded flanges reinforced by perforated stiffening rib; use on columns and for finishing masonry corners.
    - 4) Bull nose cornerbead, radius 3/4 inch (19.1 mm) minimum, with expanded flanges; use at locations indicated on Drawings.
  - e. Casing Beads: Fabricated from zinc or zinc-coated (galvanized) steel; square-edged style; with expanded flanges.



- f. Control Joints: Fabricated from zinc or zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
  - g. Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
  - h. Two-Piece Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4 to 5/8 inch (6.34 to 16 mm) wide; with perforated flanges.
3. Plastic Accessories: Fabricated from high-impact PVC.
- a. Cornerbeads: With perforated flanges.
    - 1) Small nose cornerbead; use unless otherwise indicated.
    - 2) Bull nose cornerbead, radius 3/4 inch (19.1 mm) minimum; use at locations indicated on Drawings.
  - b. Casing Beads: With perforated flanges in depth required to suit plaster bases indicated and flange length required to suit applications indicated.
    - 1) Square-edge style; use unless otherwise indicated.
    - 2) Bull-nose style, radius 3/4 inch (19.1 mm) minimum; use at locations indicated on Drawings.
  - c. Control Joints: One-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
  - d. Expansion Joints: Two-piece type, formed to produce slip-joint and square-edged 1/2-inch- (13-mm-) **OR** 1-inch- (25-mm-) **OR** 1-1/2-inch- (38-mm-), **as directed**, wide reveal; with perforated concealed flanges.
- C. Miscellaneous Materials
- 1. Water for Mixing: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
  - 2. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, 1/2 inch (13 mm) long, free of contaminants, manufactured for use in portland cement plaster.
  - 3. Bonding Compound: ASTM C 932.
  - 4. Steel Drill Screws: For metal-to-metal fastening, ASTM C 1002 or ASTM C 954, as required by thickness of metal being fastened; with pan head that is suitable for application; in lengths required to achieve penetration through joined materials of no fewer than three exposed threads.
  - 5. Fasteners for Attaching Metal Lath to Substrates: Complying with ASTM C 1063.
  - 6. Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch (1.21-mm) diameter, unless otherwise indicated.
  - 7. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
    - a. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
    - b. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
  - 8. Acoustical Sealant: As specified in Division 7 Section "Joint Sealants".
    - a. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Plaster Materials
- 1. Portland Cement: ASTM C 150, Type I **OR** Type II, **as directed**.
    - a. Color for Finish Coats: White **OR** Gray, **as directed**.
  - 2. Masonry Cement: ASTM C 91, Type N.
    - a. Color for Finish Coats: White **OR** Gray, **as directed**.
  - 3. Plastic Cement: ASTM C 1328.
  - 4. Colorants for Job-Mixed Finish Coats: Colorfast mineral pigments that produce finish plaster color to match sample.



5. Lime: ASTM C 206, Type S; or ASTM C 207, Type S.
6. Sand Aggregate: ASTM C 897.
  - a. Color for Job-Mixed Finish Coats: White **OR** In color matching sample, **as directed**.
7. Perlite Aggregate: ASTM C 35.
8. Exposed Aggregates for Finish Coats: For marblecrete finish, clean, sound, crushed marble matching color and size gradation of sample.
9. Ready-Mixed Finish-Coat Plaster: Mill-mixed portland cement, aggregates, coloring agents, and proprietary ingredients.
  - a. Color: As selected from manufacturer's full range.
10. Acrylic-Based Finish Coatings: Factory-mixed acrylic-emulsion coating systems, formulated with colorfast mineral pigments and fine aggregates; for use over portland cement plaster base coats. Include manufacturer's recommended primers and sealing topcoats for acrylic-based finishes.
  - a. Color: As selected from manufacturer's full range.

#### E. Plaster Mixes

1. General: Comply with ASTM C 926 for applications indicated.
  - a. Fiber Content: Add fiber to base-coat mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed 1 lb of fiber/cu. yd. (0.6 kg of fiber/cu. m) of cementitious materials.
2. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:
  - a. Portland Cement Mixes:
    - 1) Scratch Coat: For cementitious material, mix 1 part portland cement and 0 to 3/4 **OR** 3/4 to 1-1/2, **as directed**, parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
    - 2) Brown Coat: For cementitious material, mix 1 part portland cement and 0 to 3/4 **OR** 3/4 to 1-1/2, **as directed**, parts lime. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
  - b. Masonry Cement Mixes:
    - 1) Scratch Coat: 1 part masonry cement and 2-1/2 to 4 parts aggregate.
    - 2) Brown Coat: 1 part masonry cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.
  - c. Portland and Masonry Cement Mixes:
    - 1) Scratch Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
    - 2) Brown Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
  - d. Plastic Cement Mixes:
    - 1) Scratch Coat: 1 part plastic cement and 2-1/2 to 4 parts aggregate.
    - 2) Brown Coat: 1 part plastic cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.
  - e. Portland and Plastic Cement Mixes:
    - 1) Scratch Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
    - 2) Brown Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
3. Base-Coat Mixes: Single base coats for two-coat plasterwork as follows:
  - a. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 0 to 3/4 part lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
  - b. Portland and Masonry Cement Mix: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
  - c. Plastic Cement Mix: Use 1 part plastic cement and 2-1/2 to 4 parts aggregate.



4. Base-Coat Mixes: Single base coats for two-coat plasterwork as follows:
  - a. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
  - b. Masonry Cement Mix: Use 1 part masonry cement and 2-1/2 to 4 parts aggregate.
  - c. Plastic Cement Mix: Use 1 part plastic cement and 2-1/2 to 4 parts aggregate.
5. Job-Mixed Finish-Coat Mixes:
  - a. Portland Cement Mix: For cementitious materials, mix 1 part portland cement and 3/4 to 1-1/2 **OR** 1-1/2 to 2, **as directed**, parts lime. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
  - b. Masonry Cement Mix: 1 part masonry cement and 1-1/2 to 3 parts aggregate.
  - c. Portland and Masonry Cement Mix: For cementitious materials, mix 1 part portland cement and 1 part masonry cement. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
  - d. Plastic Cement Mix: 1 part plastic cement and 1-1/2 to 3 parts aggregate.
6. Factory-Prepared Finish-Coat Mixes: For ready-mixed finish-coat plasters or acrylic-based finish coatings, comply with manufacturer's written instructions.

### 1.3 EXECUTION

#### A. Examination

1. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### B. Preparation

1. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.
2. Prepare solid substrates for plaster that are smooth or that do not have the suction capability required to bond with plaster according to ASTM C 926.

#### C. Installation, General

1. Fire-Resistance-Rated Assemblies: Install components according to requirements for design designations from listing organization and publication indicated on Drawings.
2. Sound Attenuation Blankets: Where required, install blankets before installing lath unless blankets are readily installed after lath has been installed on one side.
3. Acoustical Sealant: Where required, seal joints between edges of plasterwork and abutting construction with acoustical sealant.

#### D. Installing Metal Lath

1. Expanded-Metal Lath: Install according to ASTM C 1063.
  - a. Partition Framing and Vertical Furring: Install flat diamond-mesh **OR** flat rib **OR** welded-wire **OR** woven-wire, **as directed**, lath.
  - b. Flat-Ceiling and Horizontal Framing: Install flat diamond-mesh **OR** flat rib **OR** 3/8-inch (9.5-mm) rib lath **OR** welded-wire **OR** woven-wire, **as directed**, lath.
  - c. Curved-Ceiling Framing: Install flat diamond-mesh **OR** welded-wire **OR** flat woven-wire, **as directed**, lath.
  - d. On Solid Surfaces, Not Otherwise Furred: Install self-furring, diamond-mesh **OR** welded-wire **OR** woven-wire, **as directed**, lath.

#### E. Installing Accessories

1. Install according to ASTM C 1063 and at locations indicated on Drawings.
2. Reinforcement for External Corners:
  - a. Install lath-type, external-corner reinforcement at exterior locations.
  - b. Install cornerbead at interior and exterior, **as directed**, locations.



3. Control Joints: Install control joints at locations indicated on Drawings **OR** in specific locations approved for visual effect as follows, **as directed**:
  - a. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
    - 1) Vertical Surfaces: 144 sq. ft. (13.4 sq. m).
    - 2) Horizontal and other Nonvertical Surfaces: 100 sq. ft. (9.3 sq. m).
  - b. At distances between control joints of not greater than 18 feet (5.5 m) o.c.
  - c. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
  - d. Where control joints occur in surface of construction directly behind plaster.
  - e. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

#### F. Plaster Application

1. General: Comply with ASTM C 926.
  - a. Do not deviate more than plus or minus 1/4 inch in 10 feet (6.4 mm in 3 m) from a true plane in finished plaster surfaces, as measured by a 10-foot (3-m) straightedge placed on surface.
  - b. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
  - c. Provide plaster surfaces that are ready to receive field-applied finishes indicated.
2. Bonding Compound: Apply on unit masonry and concrete plaster bases.
3. Walls; Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork, on masonry or on concrete; 3/4-inch (19-mm) thickness.
  - a. Portland cement mixes.
  - b. Masonry cement mixes.
  - c. Portland and masonry cement mixes.
  - d. Plastic cement mixes.
  - e. Portland and plastic cement mixes.
4. Ceilings; Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork; 1/2 inch (13 mm) thick **OR** 3/4 inch (19 mm) thick on concrete, **as directed**.
  - a. Portland cement mixes.
  - b. Masonry cement mixes.
  - c. Portland and masonry cement mixes.
  - d. Plastic cement mixes.
  - e. Portland and plastic cement mixes.
5. Walls; Base-Coat Mix: Scratch coat for two-coat plasterwork, 3/8 inch (10 mm) thick on concrete masonry **OR** 1/4 inch (6 mm) thick on concrete, **as directed**.
  - a. Portland cement mixes.
  - b. Masonry cement mixes.
  - c. Portland and masonry cement mixes.
  - d. Plastic cement mixes.
  - e. Portland and plastic cement mixes.
6. Ceilings; Base-Coat Mix: Scratch coat for two-coat plasterwork, 1/4 inch (6 mm) thick on concrete.
  - a. Portland cement mixes.
  - b. Masonry cement mixes.
  - c. Portland and masonry cement mixes.
  - d. Plastic cement mixes.
  - e. Portland and plastic cement mixes.
7. Plaster Finish Coats: Apply to provide float **OR** dash **OR** scraped trowel-textured **OR** skip trowel-textured **OR** brocade (knock-down dash) **OR** trowel sweep **OR** combed **OR** sacked (California mission) **OR** English **OR** marblecrete, **as directed**, finish to match sample.



8. Acrylic-Based Finish Coatings: Apply coating system, including primers, finish coats, and sealing topcoats, according to manufacturer's written instructions.
  9. Concealed Exterior Plasterwork: Where plaster application will be used as a base for adhered finishes, omit finish coat.
  10. Concealed Interior Plasterwork:
    - a. Where plaster application will be concealed behind built-in cabinets, similar furnishings, and equipment, apply finish coat.
    - b. Where plaster application will be concealed above suspended ceilings and in similar locations, finish coat may be omitted.
    - c. Where plaster application will be used as a base for adhesive application of tile and similar finishes, omit finish coat.
- G. Plaster Repairs
1. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.
- H. Protection
1. Remove temporary protection and enclosure of other work. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 09 22 13 00b



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## SECTION 09 22 16 13 - NON-LOAD-BEARING STEEL FRAMING

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. This Section includes non-load-bearing steel framing members for the following applications:
  - a. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.).
  - b. Interior suspension systems (e.g., supports for ceilings, suspended soffits, etc.).

#### C. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittal:
  - a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
    - 1) Include statement indicating costs for each product having recycled content.

#### D. Quality Assurance

1. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
2. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

### 1.2 PRODUCTS

#### A. Non-Load-Bearing Steel Framing, General

1. Recycled Content of Steel Products: Provide products with average recycled content of steel products such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
  - a. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
  - b. Protective Coating: ASTM A 653/A 653M, G40 (Z120) **OR** ASTM A 653/A 653M, G60 (Z180) **OR** Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G40 (Z120), **as directed**, hot-dip galvanized, unless otherwise indicated.

#### B. Suspension System Components

1. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.
2. Hanger Attachments to Concrete:
  - a. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.



- 1) Type: Cast-in-place anchor, designed for attachment to concrete forms **OR** Postinstalled, chemical anchor **OR** Postinstalled, expansion anchor, **as directed**.
- b. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.
3. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch (4.12-mm) diameter.
4. Flat Hangers: Steel sheet, in size indicated on Drawings **OR** 1 by 3/16 inch (25.4 by 4.76 mm) by length indicated, **as directed**.
5. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch (1.37 mm) and minimum 1/2-inch- (12.7-mm-) wide flanges.
  - a. Depth: As indicated on Drawings **OR** 2-1/2 inches (64 mm) **OR** 2 inches (51 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
6. Furring Channels (Furring Members):
  - a. Cold-Rolled Channels: 0.0538-inch (1.37-mm) bare-steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flanges, 3/4 inch (19.1 mm) deep.
  - b. Steel Studs: ASTM C 645.
    - 1) Minimum Base-Metal Thickness: As indicated on Drawings **OR** 0.0179 inch (0.45 mm) **OR** 0.0312 inch (0.79 mm), **as directed**.
    - 2) Depth: As indicated on Drawings **OR** 1-5/8 inches (41.3 mm) **OR** 2-1/2 inches (63.5 mm) **OR** 3-5/8 inches (92.1 mm), **as directed**.
  - c. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22.2 mm) deep.
    - 1) Minimum Base Metal Thickness: As indicated on Drawings **OR** 0.0179 inch (0.45 mm) **OR** 0.0312 inch (0.79 mm), **as directed**.
  - d. Resilient Furring Channels: 1/2-inch- (12.7-mm-) deep members designed to reduce sound transmission.
    - 1) Configuration: Asymmetrical **OR** Hat shaped, **as directed**.
7. Grid Suspension System for Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

#### C. Steel Framing For Framed Assemblies

1. Steel Studs and Runners: ASTM C 645.
  - a. Minimum Base-Metal Thickness: As indicated on Drawings **OR** 0.0179 inch (0.45 mm) **OR** 0.027 inch (0.7 mm) **OR** 0.0312 inch (0.79 mm), **as directed**.
  - b. Depth: As indicated on Drawings **OR** 3-5/8 inches (92.1 mm) **OR** 6 inches (152.4 mm) **OR** 4 inches (101.6 mm) **OR** 2-1/2 inches (63.5 mm) **OR** 1-5/8 inches (41.3 mm), **as directed**.
2. Slip-Type Head Joints: Where indicated, provide one of the following:
  - a. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- (50.8-mm-) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
  - b. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- (50.8-mm-) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
  - c. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
3. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
4. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
  - a. Minimum Base-Metal Thickness: As indicated on Drawings **OR** 0.0179 inch (0.45 mm) **OR** 0.027 inch (0.7 mm) **OR** 0.0312 inch (0.79 mm), **as directed**.



5. Cold-Rolled Channel Bridging: 0.0538-inch (1.37-mm) bare-steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flanges.
  - a. Depth: As indicated on Drawings **OR** 1-1/2 inches (38.1 mm), **as directed**.
  - b. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38.1 by 38.1 mm), 0.068-inch- (1.73-mm-) thick, galvanized steel.
6. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
  - a. Minimum Base Metal Thickness: As indicated on Drawings **OR** 0.0179 inch (0.45 mm) **OR** 0.0312 inch (0.79 mm), **as directed**.
  - b. Depth: As indicated on Drawings **OR** 7/8 inch (22.2 mm) **OR** 1-1/2 inches (38.1 mm), **as directed**.
7. Resilient Furring Channels: 1/2-inch- (12.7-mm-) deep, steel sheet members designed to reduce sound transmission.
  - a. Configuration: Asymmetrical **OR** Hat shaped, **as directed**.
8. Cold-Rolled Furring Channels: 0.0538-inch (1.37-mm) bare-steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flanges.
  - a. Depth: As indicated on Drawings **OR** 3/4 inch (19.1 mm), **as directed**.
  - b. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare-steel thickness of 0.0312 inch (0.79 mm).
  - c. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.
9. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (31.8 mm), wall attachment flange of 7/8 inch (22.2 mm), minimum bare-metal thickness of 0.0179 inch (0.45 mm), and depth required to fit insulation thickness indicated.

#### D. Auxiliary Materials

1. General: Provide auxiliary materials that comply with referenced installation standards.
  - a. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
2. Isolation Strip at Exterior Walls: Provide one of the following:
  - a. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
  - b. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

### 1.3 EXECUTION

#### A. Preparation

1. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
  - a. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
2. Coordination with Sprayed Fire-Resistive Materials:
  - a. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (600 mm) o.c.
  - b. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

#### B. Installation, General

1. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.



- a. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
  - b. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
  - c. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
  - d. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
2. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
  3. Install bracing at terminations in assemblies.
  4. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

#### C. Installing Suspension Systems

1. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.
2. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
3. Suspend hangers from building structure as follows:
  - a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
    - 1) Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  - b. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
    - 1) Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
  - c. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
  - d. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
  - e. Do not attach hangers to steel roof deck.
  - f. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
  - g. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
  - h. Do not connect or suspend steel framing from ducts, pipes, or conduit.
4. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
5. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
6. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
7. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

#### D. Installing Framed Assemblies

1. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.



2. Install studs so flanges within framing system point in same direction.
  - a. Space studs as follows:
    - 1) Single-Layer Application: 16 inches (406 mm) **OR** 24 inches (610 mm) **OR** 400 mm **OR** 600 mm, **as directed**, o.c., unless otherwise indicated.
    - 2) Multilayer Application: 16 inches (406 mm) **OR** 24 inches (610 mm) **OR** 400 mm **OR** 600 mm, **as directed**, o.c., unless otherwise indicated.
    - 3) Tile backing panels: 16 inches (406 mm) **OR** 400 mm, **as directed**, o.c., unless otherwise indicated.
  3. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
    - a. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
    - b. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
      - 1) Install two studs at each jamb, unless otherwise indicated.
      - 2) Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (12.7-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
      - 3) Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
    - c. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
    - d. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
      - 1) Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
    - e. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
    - f. Curved Partitions:
      - 1) Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
      - 2) Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of not less than 2 studs at ends of arcs, place studs 6 inches (150 mm) o.c.
  4. Direct Furring:
    - a. Screw to wood framing.
    - b. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
  5. Z-Furring Members:
    - a. Erect insulation (specified in Division 7 Section "Building Insulation") vertically and hold in place with Z-furring members spaced 24 inches (610 mm) **OR** 600 mm, **as directed**, o.c.
    - b. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (600 mm) o.c.
    - c. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (300 mm) from corner and cut insulation to fit.
  6. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

END OF SECTION 09 22 16 13



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
09 22 36 13	09 22 13 00	Gypsum Plaster
09 22 36 13	09 22 13 00a	Gypsum Veneer Plaster
09 22 36 13	09 22 13 00b	Portland Cement Plaster



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## SECTION 09 22 36 23 - LATH AND PLASTER RENOVATION

### GENERAL

#### Description Of Work

1. This specification covers the furnishing and installation of materials for lath and plaster 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.

#### Quality Assurance

2. Regulatory Requirements:
  - a. Plaster Partitions: Listed and labeled for fire-protective ratings as indicated or scheduled.
  - b. Plaster 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.

#### Submittals

3. Product Data: Submit in accordance with Detailed Scope of Work. Include each type of plaster material, metal lath, and lathing accessories to be installed.

#### Delivery, Storage, And Handling

4. General:
  - a. Plastering Materials: Deliver in original unopened containers and store off ground and under cover.
  - b. Metal Lath and Accessories: Protect from rusting during storage.
  - c. Rusted or Water Damaged Materials: Subject to rejection before or after installation.

#### Project Conditions

5. Environmental Requirements: Comply with Detailed Scope of Work.
  - a. Cold-Weather Protection: Do not apply plaster if ambient temperature is less than 4 degrees C (40 degrees F) or more than 26 degrees C (80 degrees F). Maintain this temperature range in all areas 7 days prior to application, during application, and for 7 days after plaster is set.
  - b. Hot-Weather Protection: Protect plaster against uneven or excessive evaporation during dry, hot weather and from strong blasts of dry air, either natural or artificial.
  - c. Ventilation: Ventilate building spaces as required to remove water in excess of that required for hydration of plaster. Begin ventilation immediately after plaster is applied and continue until it sets.
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.
  - a. Sequence plaster application with installation and protection of other work so that neither will be damaged by installation of other.

### PRODUCTS



## Materials

9. Materials for Patching, Extending, and Matching:
  - a. Provide same products or types of construction as 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 any necessary testing, and workmanship by use of existing as sample of comparison.
    - 2) Patching, extending, and matching of 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 shall be performed as necessary to make work complete and consistent.
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. Sheet Metal Reinforcement (Alternate to Wood Blocking): 1.52 mm (16 gage) minimum.
11. Suspended Ceiling Metals:
  - a. Main Runners (Primary Members): 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. Cross Furring (Furring Channels): Hat-shaped galvanized steel furring channels, minimum 0.46 mm (25 gage).
  - c. 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).
12. Lath:
  - a. Metal Lath: ASTM C 847, galvanized expanded metal.
    - 1) Weight: In compliance with ASTM C 841 for conditions and spacing of supports.
  - b. Gypsum Lath: ASTM C 37, plain. Provide Type X at fire-rated assemblies.
    - 1) Thickness: As indicated or specified and in compliance with ASTM C 841 for conditions and spacing of supports.
13. Fasteners:
  - a. Screws: ASTM C 1002, corrosion-resistant. Provide types as recommended by manufacturer for each application.
    - 1) To Metal Framing: Minimum 25 mm (1 inch), Type S.
    - 2) To Wood Framing: Minimum 32 mm (1-1/4 inch), Type W bugle head.
14. Accessories: ASTM C 841, galvanized steel.
  - a. Comer Beads: Small nose with expanded flanges, unless otherwise indicated.
  - b. Casing Beads: Square-edged style. with short or expanded flanges to suit kinds of plaster bases indicated.
  - c. Control Joints: Prefabricated folded pair of non-perforated screeds in M-shaped configuration, with expanded or perforated flanges.
    - 1) Provide removable protective tape on plaster face of control joints.
  - d. Cornerite: Galvanized expanded metal lath in accordance with ASTM C 841.
15. Gypsum Plaster Materials: ASTM C 28.
  - a. Base Coat Plasters: One of following:
    - 1) Gypsum ready-mixed plaster with mill-mixed perlite aggregate.
    - 2) Gypsum wood-fibered plaster, ASTM C 28, Type N.
  - b. Finish Coat Plasters: One of following:
    - 1) Gypsum ready-mixed finished plaster, manufacturers standard mill-mixed gauged interior finish.



- 2) Gypsum Gauging Plaster: ASTM C 28, Type G.
  - c. Quicklime: ASTM C 5.
  - d. Sand: ASTM C 35.
  - e. Finishing Hydrated Limes: ASTM C 206, Type S, special hydrated lime for finishing purposes.
  - f. Bonding Compound for Gypsum Plaster: ASTM C 631.
  - g. Water: Clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or substances that may be deleterious to plaster or metals in contact with plaster.
16. Sound-Isolation Materials:
- a. Sound Insulation: ASTM C 665, Type I (unfaced) mineral-fiber blankets, 12 to 16 kg per cu m (0.75 to 1 PCF), thickness as indicated or scheduled, or required by fire-rated assembly.
  - b. Acoustical Sealant:
    - 1) Concealed: ASTM C 919 nondrying, non-hardening, 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.
17. Gypsum Plaster Mixes: As recommended by manufacturer:
- a. Scratch Coat:
    - 1) Over Metal Lath: Gypsum wood-fibered plaster, neat or with job-mixed sand.
    - 2) Over Gypsum Lath: Gypsum neat plaster with job-mixed sand.
    - 3) Over Unit Masonry: Gypsum wood-fibered plaster, neat or with job-mixed sand.
  - b. Brown Coat:
    - 1) Over Metal Lath: Gypsum wood-fibered plaster, with job-mixed sand.
    - 2) Over Gypsum Lath: Gypsum neat plaster with job-mixed sand.
    - 3) Over Unit Masonry: Gypsum wood-fibered plaster with job-mixed sand.
  - c. Finish Coat: Proportion materials for finish coats to comply with ASTM C 842 for each type of finish coat and texture indicated.
    - 1) Gypsum Gauging Plaster 1 part plaster and 2 parts lime.
      - a) Over lightweight aggregate base coats, add 15 L (1/2 cubic foot) of perlite fines or 23 kg (50 pounds) of No. 1 white silica sand per 45 kg (100 pounds) of plaster.
    - 2) Gypsum Ready-mixed Finish Plaster Neat.
  - d. Mechanically mix cementitious and aggregate materials for plasters to comply with applicable referenced application standard and with recommendations of plaster manufacturer.

## EXECUTION

### Examination

- 18. Units, Spaces, and Areas to be renovated: Comply with Detailed Scope of Work.
  - a. Verify that surfaces to receive rough carpentry are prepared to required grades and dimensions.

### 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 plastering operations.
- 22. Selective Demolition: Comply with Detailed Scope of Work.
- 23. Surface Preparation: Clean projections, dust, loose particles, grease, bond breakers, and foreign matter from surfaces to receive plaster.



- a. Do not apply plaster directly to surfaces (1) of masonry or concrete that have been coated with bituminous compound or other waterproofing agents, or (2) that have been painted or previously plastered.
- b. Before plaster work is started, wet masonry and concrete surfaces thoroughly with fine fog spray of clean water to produce uniformly moist surface.
- c. Do not apply plaster to surfaces containing frost.

#### Laying-Out Work

24. 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.
25. Contractor: Responsible for location and elevation of construction contemplated by Construction Documents.

#### Performance

26. 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.
27. Damaged Surfaces: Comply with Detailed Scope of Work.
28. Transitions from Existing to New Work: Comply with Detailed Scope of Work.
29. Isolation: Where lathing and metal support system abuts building structure horizontally and where partition/wall work abuts overhead structure, isolate work from structural movement sufficiently to prevent transfer of loads to work from building structure. Install slip or cushion-type joints to absorb deflections but maintain lateral support.
  - a. Frame both sides of control and expansion joints independently, and do not bridge joints with furring and lathing or accessories.

#### Installation Of Suspended Steel Framing

30. General: Construct ceilings of lath and plaster on suspended steel framing system in accordance with manufacturer's recommendations and Reference Standards.
31. Hanger Installation: Attach hangers to structure above ceiling to comply with NAAMM ML/SFA 920.
32. Ceiling Suspension System Components: Install In sizes and at spacings indicated but not in smaller sizes or greater spacings than those required by ASTM C 841 and NAAMM ML/SFA 920.
  - a. Wire Hangers: Space and install wire hangers in accordance with ASTM C 841 and within 150 mm (6 inches) of channel ends, unless closer spacing indicated or required for fire-resistance rated assembly.
  - b. Main Runners (Primary Members): Space and install channels in accordance with ASTM C 841, unless closer spacing indicated or required for fire-resistance rated assembly.
  - c. Cross Furring (Furring Channels): Space and install furring channels in accordance with ASTM C 841, unless closer spacing indicated or required for fire-resistance rated assembly.
33. Framing Around Openings: Frame channels and lath on suspended soffits and ceilings and at furring to receive electric lights, etc. as indicated or as necessary to complete work. Furnish and install in furring, plaster rings or access panels furnished under other sections.

#### Installation Of Steel Stud Partitions

34. General: Install steel stud partition support systems in accordance with manufacturer's recommendations and Reference Standards.
35. Steel Stud Systems: Comply with ASTM C 754.



- a. To Receive Metal Lath: Space studs in accordance with ASTM C 841 and NAAMM ML/SFA 920.
  - b. To Receive Gypsum Lath: Space studs in accordance with ASTM C 841.
36. Extend partition support systems to finish ceilings and attach to ceiling suspension members, unless otherwise indicated.

#### Metal Furring

37. General: Install in accordance with ASTM C 841 and NAAMM ML/SFA 920.
  - a. Install supplementary framing, blocking, and bracing at terminations in work and for support of fixtures, equipment services, heavy trim, grab bars, bath accessories, furnishings, and similar work to comply with manufacturer's recommendations.
38. Metal Furring to Receive Gypsum Lath: Space furring channels in accordance with ASTM C 841.
39. Metal Furring Systems:
  - a. To Receive Metal Lath: Space furring in accordance with ASTM C 841 and NAAMM ML/SFA 920.
  - b. To Receive Gypsum Lath: Space furring in accordance with ASTM C 841.
40. Isolation: Where lathing and metal support system abuts building structure horizontally and where partition/wall work abuts overhead structure, isolate work from structural movement sufficiently to prevent transfer of loads to work from building structure. Install slip or cushion-type joints to absorb deflections but maintain lateral support.
  - a. Frame both sides of control and expansion joints independently, and do not bridge joints with furring and lathing or accessories.

#### Installation Of Suspended Steel Framing

41. General: Construct ceilings of lath and plaster on suspended steel framing system in accordance with manufacturer's recommendations and Reference Standards.
42. Hanger Installation: Attach hangers to structure above ceiling to comply with NAAMM ML/SFA 920.
43. Ceiling Suspension System Components: Install in sizes and at spacings indicated but not in smaller sizes or greater spacings than those required by ASTM C 841 and NAAMM ML/SFA 920.
  - a. Wire Hangers: Space and install wire hangers in accordance with ASTM C 841 and within 150 mm (6 inches) of channel ends, unless closer spacing indicated or required for fire-resistance rated assembly.
  - b. Main Runners (Primary Members): Space and install channels in accordance with ASTM C 841, unless closer spacing indicated or required for fire-resistance rated assembly.
  - c. Cross Furring (Furring Channels): Space and install furring channels in accordance with ASTM C 841, unless closer spacing indicated or required for fire-resistance rated assembly.
44. Framing Around Openings: Frame channels and lath on suspended soffits and ceilings and at furring to receive electric lights, etc. as indicated or as necessary to complete work. Furnish and install in furring, plaster rings or access panels furnished under other sections.

#### Installation Of Steel Stud Partitions

45. General: Install steel stud partition support systems in accordance with manufacturer's recommendations and Reference Standards.
46. Steel Stud Systems: Comply with ASTM C 754.
  - a. To Receive Metal Lath: Space studs in accordance with ASTM C 841 and NAAMM ML/SFA 920.
  - b. To Receive Gypsum Lath: Space studs in accordance with ASTM C 841.
47. Extend partition support systems to finish ceilings and attach to ceiling suspension members, unless otherwise indicated.

#### Metal Furring

48. General: Install in accordance with ASTM C 841 and NAAMM ML/SFA 920.
  - a. Install supplementary framing, blocking, and bracing at terminations in work and for support of fixtures, equipment services, heavy trim, grab bars, bath accessories, furnishings, and similar work to comply with manufacturer's recommendations.



49. Metal Furring to Receive Gypsum Lath: Space furring channels in accordance with ASTM C 841.
50. Metal Furring Systems:
  - a. To Receive Metal Lath: Space furring in accordance with ASTM C 841 and NAAMM ML/SFA 920.
  - b. To Receive Gypsum Lath: Space furring in accordance with ASTM C 841.

#### Lathing

51. Metal Lathing: Install in accordance with ASTM C 841 and NAAMM ML/SFA 920.
  - a. At Metal Framing: Attach metal lath to furring channels with long dimension of sheet at right angles to furring channels with gage wire ties spaced not over 150 mm (6 inches) apart.
  - b. At Wood Framing: Nail metal lath to wood framing with long dimension of sheet at right angles to framing member.
  - c. Place ties where sides of sheets laps at supports and at side laps of sheets between supports. Lap metal lath not less than 13 mm (1/2 inch) at sides of sheets and 25 mm (1 inch) at ends of sheets.
  - d. Suspended and Furred Ceilings: Use 1.8 kg/sq m (3.4 pounds/SY) minimum weight diamond mesh lath.
  - e. Ceramic Tile Setting Beds: Use 1.8 kg/sq m (3.4 pounds/SY) minimum weight diamond mesh lath.
52. Gypsum Lath: Install in accordance with ASTM C 841.
  - a. Wood Framing and Furring: Install lath as follows:
    - 1) With screws to comply with lath manufacturer's directions.
    - 2) With nails.
    - 3) Provide floating angle construction.
  - b. Suspended and Furred Ceilings: Install lath to furring members with clips.
  - c. Vertical Metal Framing and Furring: Install lath as follows:
    - 1) With screws.
    - 2) With clips, supplemented by screws where required by lath manufacturer.
    - 3) Where sound-rated partitions are indicated, attach lath with resilient clips.

#### Installation Of Accessories

53. Accessories: Install as required to repair area of work to match existing. Install in accordance with ASTM C 841. Miter or cope accessories at comers; Install with tight joints and in alignment. Attach accessories securely to plaster bases to hold accessories in place and alignment during plastering.
54. Interior Corners: Apply cornerite.
55. Corner Beads: Install corner beads tightly secured to lath at exposed exterior corners.
56. Casing Beads: Install at terminations of plaster work, except where plaster passes behind and is concealed by other work and where metal screeds, bases, or metal frames act as casing beads.
57. Control Joints: Install at locations indicated or, if not indicated, at spacings and locations required by Reference Standards. Coordinate specific locations with the Owner.
58. Access Panels: Provide access panels as required for maintenance of concealed plumbing work in coordination with Division 15 Section "Plumbing." Tiled Areas: Coordinate with Division 9 Section "Ceramic Tile."
59. Sound-Rated Plaster Work: Where sound-rated plaster work is indicated by STC ratings or other notation:
  - a. Acoustical Sealant: Seal work at perimeters, control joints, openings, and penetrations with continuous bead of acoustical sealant. Comply with ASTM C 919 and plastering manufacturer's recommendations for location of sealant beads.
  - b. Sound Insulation: Install insulation blankets within stud cavities of sound-rated partition assemblies where indicated.

#### Plastering

60. Plastering: Comply with ASTM C 842 in thickness to match existing.



- a. Preparation: Remove loose, fractured, or separated plaster to face of substrate. repairing lath at substrate to ensure repair area bounded by solid and sound existing plaster construction.
    - 1) Prepare monolithic surfaces for bonded base coats and use bonding compound to comply with Reference Standards for conditioning of monolithic surfaces.
  - b. Grout hollow metal frames, bases, and similar work with base-mat plaster material, and prior to lathing where necessary. Except where full grouting is indicated or required for fire-resistance rating, grout at least 150 mm (6 inches) at each jamb anchor dip.
  - c. Plaster flush with metal frames and other built-in metal items or accessories that act as plaster ground, unless otherwise indicated. Where plaster is not terminated at metal by casing beads, cut base coat free from metal before plaster sets and groove finish coat at junctures with metal.
61. Preparation: Check metal grounds, comer beads, screeds, and other accessories carefully for alignment before starting plaster application. Check expansion and control joints and supporting metal structures to ensure that expansion and control joints can move unrestrained.
62. Plaster: Apply In accordance with ASTM C 842 in thickness to match existing:
- a. Use three-coat work over following plaster bases:
    - 1) Metal lath.
    - 2) Gypsum lath attached to ceiling supports by clips.
    - 3) Gypsum lath attached to ceiling supports spaced over 400 mm (16 inches) OC.
    - 4) Gypsum lath, 9.5 mm (3/8 inch) thick, with separate vapor retarder behind.
  - b. Use two-coat work over following bases.
    - 1) Gypsum lath except for installations requiring three-coat work.
    - 2) Unit masonry.
    - 3) Concrete, cast-in-place or precast when surface condition complies with ASTM C 842 for plaster bonded to solid base.
  - c. First Coat: Apply first coat of plaster with such force to secure good key.
  - d. Finish Coats: Apply troweled finish coats unless otherwise indicated.
63. Workmanship: Perform work true to line, straight, and plumb.
- a. Finished Surfaces: Free from waves, dents, bumps, cracks, pits. checks, streaks, catfaces, blisters, or other defects. Cutout and properly replace defective areas.
  - b. Execute work to avoid any irregularity occurring at point or place where one section is joined to another.
  - c. Arises and Angles: True and sharp.
64. Tolerances: Plaster surface plane within plus/minus 3 mm in 3 000 mm (1/8 inch in 10 feet).

#### Integrating Existing Work

65. Protection: Comply with Detailed Scope of Work.

#### Adjustments

66. Partition Removal: Comply with Detailed Scope of Work.

#### Dust Control

67. Dust: Comply with Detailed Scope of Work.

#### Patching And Cleaning

68. Cutting and Patching: Do necessary cutting, patching, and repairing and pointing up of plastering after other work is in place to restore defective areas. Repair or replace work to eliminate blisters, buckles, excessive crazing and check-cracking, dry outs, efflorescence, sweat-outs, and similar defects and where bond to substrate has failed.
- a. Sand smooth-troweled finishes lightly to remove trowel marks and arises.
69. Cleaning: As rapidly as plastering is completed in each space, clean up rubbish, utensils, and surplus material, sweep floor and leave in neat condition for work of others.
- a. When general plastering is concluded, remove plastering rubbish, equipment, and surplus materials from premises.
  - b. Clean surfaces splattered with plaster.



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END OF SECTION 09 22 36 23



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
09 22 36 23	09 22 13 00	Gypsum Plaster
09 22 36 23	09 22 13 00a	Gypsum Veneer Plaster
09 22 36 23	09 22 13 00b	Portland Cement Plaster
09 22 36 33	09 22 13 00	Gypsum Plaster
09 22 36 33	09 22 13 00a	Gypsum Veneer Plaster
09 22 36 33	09 22 13 00b	Portland Cement Plaster
09 22 36 33	09 22 36 23	Lath and Plaster Renovation



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**SECTION 09 23 13 00 - 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 23 13 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
09 23 13 00	09 22 13 00	Gypsum Plaster
09 23 13 00	09 22 13 00a	Gypsum Veneer Plaster
09 23 13 00	09 22 13 00b	Portland Cement Plaster
09 23 13 00	09 22 36 23	Lath and Plaster Renovation
09 24 33 00	01 22 16 00	No Specification Required



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**SECTION 09 28 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 C1177/C 1177M.
    - c. Core: As indicated on Drawings **OR** 1/2 inch (12.7 mm), regular type **OR** 5/8 inch (15.9 mm), Type X, **as directed**.
  3. Cementitious Backer Units: ANSI A118.9.
    - a. Thickness: As indicated on Drawings **OR** 1/2 inch (12.7 mm), **as directed**.
- E. Trim Accessories
1. Interior Trim: ASTM C 1047.
    - a. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet **OR** Galvanized or aluminum-coated steel sheet or rolled zinc **OR** Plastic **OR** Paper-faced galvanized steel sheet, **as directed**.
    - b. Shapes:
      - 1) Cornerbead.
      - 2) Bullnose bead.
      - 3) LC-Bead: J-shaped; exposed long flange receives joint compound.
      - 4) L-Bead: L-shaped; exposed long flange receives joint compound.
      - 5) U-Bead: J-shaped; exposed short flange does not receive joint compound.
      - 6) Expansion (control) joint.
      - 7) Curved-Edge Cornerbead: With notched or flexible flanges.
  2. Exterior Trim: ASTM C 1047.
    - a. Material: Hot-dip galvanized steel sheet, plastic, or rolled zinc.
    - b. Shapes:
      - 1) Cornerbead.
      - 2) LC-Bead: J-shaped; exposed long flange receives joint compound.
      - 3) Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.
  3. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
    - a. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
    - b. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.
- F. Joint Treatment Materials
1. General: Comply with ASTM C 475/C 475M.
  2. Joint Tape:
    - a. Interior Gypsum Wallboard: Paper.
    - b. Exterior Gypsum Soffit Board: Paper.
    - c. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
    - d. Tile Backing Panels: As recommended by panel manufacturer.
  3. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
    - a. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.



- b. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping **OR** drying-type, all-purpose, **as directed**, compound.
    - 1) Use setting-type compound for installing paper-faced metal trim accessories.
  - c. Fill Coat: For second coat, use setting-type, sandable topping **OR** drying-type, all-purpose, **as directed**, compound.
  - d. Finish Coat: For third coat, use setting-type, sandable topping **OR** drying-type, all-purpose, **as directed**, compound.
  - e. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound **OR** drying-type, all-purpose compound **OR** high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish, **as directed**.
- 4. Joint Compound for Exterior Applications:
    - a. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
    - b. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.
  - 5. Joint Compound for Tile Backing Panels:
    - a. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.
    - b. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
    - c. Cementitious Backer Units: As recommended by backer unit manufacturer.

#### G. Auxiliary Materials

- 1. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- 2. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
  - a. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 3. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
  - a. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
  - b. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- 4. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
  - a. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
  - b. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
- 5. Acoustical Sealant: As specified in Division 07 Section "Joint Sealants".
  - a. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 6. Thermal Insulation: As specified in Division 07 Section "Thermal Insulation".
- 7. Vapor Retarder: As specified in Division 07 Section "Thermal Insulation".

#### H. Texture Finishes

- 1. Primer: As recommended by textured finish manufacturer.
- 2. Polystyrene Aggregate Ceiling Finish: Water-based, job-mixed, polystyrene aggregate finish with flame-spread and smoke-developed indexes of not more than 25 when tested according to ASTM E 84.
  - a. Texture: Fine **OR** Medium **OR** Coarse, **as directed**.
- 3. Aggregate Finish: Water-based, job-mixed, aggregated, drying-type texture finish for spray application.



- a. Texture: Light spatter **OR** Spatter knock-down, **as directed**.
4. Acoustical Finish: Water-based, chemical-setting or drying-type, job-mixed texture finish for spray application.
  - a. Application Thickness: 1/2 inch (12.7 mm).
  - b. Fire-Test-Response Characteristics: Indices when tested according to ASTM E 84 as follows:
    - 1) Flame Spread: Less than 25.
    - 2) Smoke Developed: Less than 450.
  - c. NRC: 0.55 according to ASTM C 423.

### 1.3 EXECUTION

#### A. Examination

1. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.
2. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

#### B. Applying And Finishing Panels, General

1. Comply with ASTM C 840.
2. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
3. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
4. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
5. Form control and expansion joints with space between edges of adjoining gypsum panels.
6. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
  - a. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
  - b. Fit gypsum panels around ducts, pipes, and conduits.
  - c. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.
7. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
8. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
9. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members, or provide control joints to counteract wood shrinkage.
10. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.



11. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.

C. Applying Interior Gypsum Board

1. Install interior gypsum board in the following locations:
  - a. Regular Type: As indicated on Drawings **OR** Vertical surfaces, unless otherwise indicated, **as directed**.
  - b. Type X: As indicated on Drawings **OR** Where required for fire-resistance-rated assembly **OR** Vertical surfaces, unless otherwise indicated, **as directed**.
  - c. Type C: As indicated on Drawings **OR** Where required for specific fire-resistance-rated assembly indicated, **as directed**.
  - d. Flexible Type: As indicated on Drawings **OR** Apply in double layer at curved assemblies, **as directed**.
  - e. Ceiling Type: As indicated on Drawings **OR** Ceiling surfaces, **as directed**.
  - f. Foil-Backed Type: As indicated on Drawings **OR as directed**.
  - g. Abuse-Resistant Type: As indicated on Drawings **OR as directed**.
  - h. High-Impact Type: As indicated on Drawings **OR as directed**.
  - i. Moisture- and Mold-Resistant Type: As indicated on Drawings **OR as directed**.
2. Single-Layer Application:
  - a. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
  - b. On partitions/walls, apply gypsum panels vertically (parallel to framing) **OR** horizontally (perpendicular to framing), **as directed**, unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
    - 1) Stagger abutting end joints not less than one framing member in alternate courses of panels.
    - 2) At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.
  - c. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
  - d. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
3. Multilayer Application:
  - a. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
  - b. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
  - c. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
  - d. Fastening Methods: Fasten base layers and face layers separately to supports with screws **OR** Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners, **as directed**.
4. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.
5. Curved Surfaces:



- a. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch- (300-mm-) long straight sections at ends of curves and tangent to them.
  - b. For double-layer construction, fasten base layer to studs with screws 16 inches (400 mm) o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches (300 mm) o.c.
- D. Applying Exterior Gypsum Panels For Ceilings And Soffits
1. Apply panels perpendicular to supports, with end joints staggered and located over supports.
    - a. Install with 1/4-inch (6.4-mm) open space where panels abut other construction or structural penetrations.
    - b. Fasten with corrosion-resistant screws.
- E. Applying Tile Backing Panels
1. Water-Resistant Gypsum Backing Board: Install at showers, tubs, and where indicated. Install with 1/4-inch (6.4-mm) gap where panels abut other construction or penetrations.
  2. Glass-Mat, Water-Resistant Backing Panel: Comply with manufacturer's written installation instructions and install at showers, tubs, and where indicated **OR** locations indicated to receive tile, **as directed**. Install with 1/4-inch (6.4-mm) gap where panels abut other construction or penetrations.
  3. Cementitious Backer Units: ANSI A108.11, at showers, tubs, and where indicated **OR** locations indicated to receive tile, **as directed**.
  4. Areas Not Subject to Wetting: Install regular-type gypsum wallboard panels to produce a flat surface except at showers, tubs, and other locations indicated to receive water-resistant panels.
  5. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.
- F. Installing Trim Accessories
1. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
  2. Control Joints: Install control joints at locations indicated on Drawings **OR** according to ASTM C 840 and in specific locations approved by the Owner for visual effect, **as directed**.
  3. Interior Trim: Install in the following locations:
    - a. Cornerbead: Use at outside corners, unless otherwise indicated.
    - b. Bullnose Bead: Use at outside corners **OR** where indicated, **as directed**.
    - c. LC-Bead: Use at exposed panel edges.
    - d. L-Bead: Use where indicated.
    - e. U-Bead: Use at exposed panel edges **OR** where indicated, **as directed**.
    - f. Curved-Edge Cornerbead: Use at curved openings.
  4. Exterior Trim: Install in the following locations:
    - a. Cornerbead: Use at outside corners.
    - b. LC-Bead: Use at exposed panel edges.
  5. Aluminum Trim: Install in locations indicated on Drawings.
- G. Finishing Gypsum Board
1. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
  2. Prefill open joints, rounded or beveled edges, and damaged surface areas.
  3. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
  4. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
    - a. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
    - b. Level 2: Panels that are substrate for tile **OR** Panels that are substrate for acoustical tile **OR** Where indicated on Drawings, **as directed**.



- c. Level 3: For surfaces receiving medium- or heavy-textured finishes before painting or heavy wallcoverings where lighting conditions are not critical **OR** Where indicated on Drawings, **as directed**.
- d. Level 4: For surfaces receiving light-textured finishes, wallcoverings, and flat paints **OR** At panel surfaces that will be exposed to view, unless otherwise indicated, **as directed**. This is generally the standard exposed finish. Gloss and semi-gloss enamel paints are not usually recommended over this level of finish. ASTM C 840 requires application of "drywall primer" on surfaces before final decoration
  - 1) Primer and its application to surfaces are specified in other Division 07.
- e. Level 5: For surfaces receiving gloss and semigloss enamels and other surfaces subject to severe lighting **OR** Where indicated on Drawings, **as directed**.
  - 1) Primer and its application to surfaces are specified in other Division 07.
- f. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.
- g. Glass-Mat, Water-Resistant Backing Panels: Finish according to manufacturer's written instructions.
- h. Cementitious Backer Units: Finish according to manufacturer's written instructions.

#### H. Applying Texture Finishes

- 1. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.
- 2. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture free of starved spots or other evidence of thin application or of application patterns.
- 3. Prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If, despite these precautions, texture finishes contact these surfaces, immediately remove droppings and overspray to prevent damage according to texture-finish manufacturer's written recommendations.

#### I. Protection

- 1. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- 2. Remove and replace panels that are wet, moisture damaged, and mold damaged.
  - a. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 28 13 00



## SECTION 09 28 13 00a - 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.




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**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).



- 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 28 13 00a



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
09 28 13 00	09 22 13 00a	Gypsum Veneer Plaster
09 28 13 00	09 01 30 91	Ceramic Tile
09 29 00 00	01 22 16 00	No Specification Required
09 29 00 00	09 28 13 00	Gypsum Board
09 29 00 00	09 23 13 00	Gypsum Board Renovation
09 29 00 00	09 28 13 00a	Gypsum Board Shaft-Wall Assemblies



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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.

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## SECTION 09 51 23 00 - ACOUSTICAL TILE CEILINGS

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. This Section includes acoustical tiles for ceilings and the following:
  - a. Concealed suspension systems.
  - b. Direct attachment of tiles to substrates with adhesive.
  - c. Direct attachment of tiles to substrates with staples.
2. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

#### C. Definitions

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

#### D. Submittals

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

#### E. Quality Assurance

1. Acoustical Testing Agency Qualifications: An independent testing laboratory, or an NVLAP-accredited laboratory, with the experience and capability to conduct the testing indicated. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.
2. Fire-Test-Response Characteristics: Provide acoustical tile ceilings that comply with the following requirements:
  - a. Fire-Resistance Characteristics: Where indicated, provide acoustical tile ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
    - 1) Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.



- 2) Identify materials with appropriate markings of applicable testing and inspecting agency.
- b. Surface-Burning Characteristics: Provide acoustical tiles with the following surface-burning characteristics complying with ASTM E 1264 for Class A **OR B OR C**, **as directed**, materials as determined by testing identical products per ASTM E 84:
  - 1) Smoke-Developed Index: 450 or less.
3. Seismic Standard: Provide acoustical tile ceilings designed and installed to withstand the effects of earthquake motions according to the following:
  - a. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.
  - b. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings--Seismic Zones 0-2."
  - c. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies--Seismic Zones 3 & 4."
  - d. 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 tiles, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
2. Before installing acoustical tiles, permit them to reach room temperature and a stabilized moisture content.
3. Handle acoustical tiles carefully to avoid chipping edges or damaging units in any way.

## 1.2 PRODUCTS

### A. Acoustical Tiles, General

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



added to inhibit growth of mold and mildew and showing no mold or mildew growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

- B. Acoustical Tiles For Acoustical Tile Ceiling
1. Classification: Provide fire-resistance-rated, **as directed**, tiles complying with ASTM E 1264 for type, form, and pattern as follows:
    - a. Type III, mineral base with painted finish; Form 1, nodular **OR** 2, water felted **OR** 4, cast or molded, **as directed**.
    - b. Pattern: C (perforated, small holes) **OR** CD (perforated, small holes and fissured) **OR** CE (perforated, small holes and lightly textured) **OR** D (fissured) **OR** E (lightly textured) **OR** F (heavily textured) **OR** G (smooth) **OR** I (embossed) **OR** J (embossed-in-register) **OR** As indicated by manufacturer's designation, **as directed**.
  2. Color: White **OR** As selected from manufacturer's full range **OR** Match sample **OR** As indicated by manufacturer's designation **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
  3. LR: Not less than 0.65 **OR** 0.70 **OR** 0.75 **OR** 0.80, **as directed**.
  4. NRC: Not less than 0.50 **OR** 0.55 **OR** 0.60 **OR** 0.65 **OR** 0.70, **as directed**.
  5. CAC: Not less than 20 **OR** 25 **OR** 30 **OR** 35 **OR** 40, **as directed**.
  6. AC: Not less than 170 **OR** 180 **OR** 190 **OR** 200 **OR** 210, **as directed**.
  7. Edge/Joint Detail: Square, kerfed and rabbeted, or tongue and grooved, or butt **OR** Beveled, kerfed and rabbeted, or tongue and grooved, or butt **OR** Beveled, kerfed and rabbeted long edges and square, butt on short edges, **as directed**.
  8. Thickness: 5/8 inch (15 mm) **OR** 3/4 inch (19 mm) **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
  9. Modular Size: 12 by 12 inches (305 by 305 mm) **OR** 300 by 300 mm **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
  10. Antimicrobial Treatment: Broad spectrum fungicide and bactericide **OR** Fungicide, **as directed**, based.
- C. Metal Suspension Systems, General
1. Recycled Content: Provide products made from steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
  2. Metal Suspension System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
  3. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
  4. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
    - a. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
      - 1) Type: Cast-in-place **OR** Postinstalled expansion **OR** Postinstalled bonded, **as directed**, anchors.
      - 2) Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
      - 3) Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchors.
    - b. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without



failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.

5. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
    - a. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
    - b. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) **OR** 0.135-inch- (3.5-mm-), **as directed**, diameter wire.
  6. Hanger Rods **OR** Flat Hangers, **as directed**: Mild steel, zinc coated or protected with rust-inhibitive paint.
  7. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1-mm-) thick, galvanized steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.
  8. Seismic Struts: Manufacturer's standard compression struts designed to accommodate lateral forces.
  9. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical tiles in-place.
- D. Metal Suspension System For Acoustical Tile Ceiling
1. Direct-Hung, Double-Web, Fire-Rated, **as directed**, Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, G30 (Z90) coating designation.
    - a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
    - b. Access: Upward **OR** Downward, **as directed**, and end pivoted, **OR** side pivoted, **as directed**, with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.
  2. Indirect-Hung, Fire-Rated, **as directed**, Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, G30 (Z90) coating designation.
    - a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
    - b. Carrying Channels: Cold-rolled steel, 0.059850-inch- (1.52-mm-) minimum base (uncoated) metal thickness, not less than 3/16-inch- (4.7-mm-) wide flanges by 1-1/2-inch- (38-mm-) deep steel channels, 475 lb/1000 feet (0.707 kg/m), with rust-inhibitive paint finish **OR** hot-dip galvanized according to ASTM A 653/A 653M, G60 (Z180) coating designation, **as directed**.
    - c. Access: Where access is indicated, provide special cross runners or split splines to allow for removal of acoustical units in indicated access areas. Identify access tile with manufacturer's standard unobtrusive markers for each access unit.
- E. Metal Edge Moldings And Trim
1. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
    - a. Provide manufacturer's standard edge moldings that fit acoustical tile edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.
    - b. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
  2. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
    - a. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability



properties of aluminum extrusions complying with ASTM B 221 (ASTM B 221M) for Alloy and Temper 6063-T5.

- b. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.
- c. Conversion-Coated Finish: AA-M12C42 (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating).
- d. Conversion-Coated and Factory-Primed Finish: AA-M12C42R1x (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating; organic coating as follows):
  - 1) Manufacturer's standard factory-applied prime-coat finish ready for field painting.
- e. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
- f. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; organic coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
  - 1) Organic Coating: Thermosetting, enamel primer/topcoat system with a minimum dry film thickness of 0.8 to 1.2 mils (0.02 to 0.03 mm).

#### F. Acoustical Sealant

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

#### G. Miscellaneous Materials

1. Tile Adhesive: Type recommended by tile manufacturer, bearing UL label for Class 0-25 flame spread.
  - a. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Staples: 5/16-inch- (8-mm-) long, divergent-point staples.

### 1.3 EXECUTION

#### A. Preparation

1. Testing Substrates: Before installing adhesively applied tiles on wet-placed substrates such as cast-in-place concrete or plaster, test and verify that moisture level is below tile manufacturer's recommended limits.
2. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders, and comply with layout shown on reflected ceiling plans.

#### B. Installation, Suspended Acoustical Tile Ceilings

1. General: Install acoustical tile ceilings to comply with ASTM C 636 **OR** 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.  
**OR**  
Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  - c. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
  - d. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.  
**OR**  
Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
  - e. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
  - f. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
  - g. Do not attach hangers to steel deck tabs.
  - h. Do not attach hangers to steel roof deck. Attach hangers to structural members.
  - i. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
  - j. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
3. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
  4. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical tiles.
    - a. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
    - b. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
    - c. Do not use exposed fasteners, including pop rivets, on moldings and trim.
  5. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
  6. Arrange directionally patterned acoustical tiles as follows:
    - a. As indicated on reflected ceiling plans.  
**OR**  
Install tiles with pattern running in one direction parallel to long **OR** short, **as directed**, axis of space.  
**OR**



- Install tiles in a basket-weave pattern.
7. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material.
    - a. Fit adjoining tile to form flush, tight joints. Scribe and cut tile for accurate fit at borders and around penetrations through tile.
    - b. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tile and moldings, spaced 12 inches (305 mm) o.c.
    - c. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.
- C. Installation, Directly Attached Acoustical Tile Ceilings
1. Adhesive Installation: Install acoustical tile by bonding to substrate, using amount of adhesive and procedure recommended in writing by tile manufacturer and as follows:
    - a. Remove loose dust from backs of tiles by brushing and prime them with a thin coat of adhesive.
    - b. Install splines in joints between tiles; maintain level of bottom surface of tiles to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m) and not exceeding 1/4 inch (6.35 mm) cumulatively.
    - c. Maintain tight butt joints, aligned in both directions and coordinated with ceiling fixtures.
  2. Stapled Installation: Fasten acoustical tile to substrate using a minimum of two staples per tile that are installed in flanges of tile and as follows:
    - a. Form double-lapped joint between tiles by securely pressing tile tongues into corresponding tile grooves.
    - b. Maintain level of bottom surface of tiles to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m) and not exceeding 1/4 inch (6.35 mm) cumulatively. Shim tile or correct substrate as required to maintain tolerance.
    - c. Maintain tight butt joints, aligned in both directions and coordinated with ceiling fixtures.
  3. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical units.
  4. Arrange directionally patterned acoustical tiles as follows:
    - a. As indicated on reflected ceiling plans.  
**OR**  
Install tiles with pattern running in one direction parallel to long axis of space.  
**OR**  
Install tiles with pattern running in one direction parallel to short axis of space.  
**OR**  
Install tiles in a basket-weave pattern.
- D. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
  2. Tests and Inspections: Testing and inspecting of completed installations of acoustical tile ceiling hangers and anchors and fasteners shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with installations of acoustical tile ceiling hangers for the next area until test results for previously completed installations of acoustical tile ceiling hangers show compliance with requirements.
    - a. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no tiles have been installed.
      - 1) Within each test area, testing agency will select 1 of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select one of every 2 postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
      - 2) When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.



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3. Remove and replace acoustical tile ceiling hangers and anchors and fasteners that do not pass tests and inspections and retest as specified above.

E. Cleaning

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

END OF SECTION 09 51 23 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
09 53 23 00	09 51 13 00	Acoustical Panel Ceilings

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## SECTION 09 54 23 00 - ACOUSTICAL METAL PAN CEILINGS

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. Section includes clip-in, lay-in, snap-in, and torsion-spring acoustical metal pans and the following suspension system for ceilings:
  - a. Direct hung, exposed tee and slot-bolt grid.
  - b. Direct-hung and Indirect-hung, concealed grid designed to support metal pans.
2. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

#### C. Definitions

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

#### D. Performance Requirements

1. Structural Performance: Exterior snap-in metal pan ceilings shall withstand exterior exposure and the effects of gravity loads and the following loads and stresses without showing permanent deformation of ceiling system components including pans and suspension system; noise or metal fatigue caused by vibration, deflection, and displacement of ceiling units; or permanent damage to fasteners and anchors.
  - a. Wind Load: Uniform pressure of 20 lbf/sq. ft. (960 Pa) **OR** of 30 lbf/sq. ft. (1436 Pa) **OR** as indicated on Drawings, **as directed**, acting inward or outward.
2. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - a. Temperature Change (Range): 100 deg F (55 deg C).

#### E. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
  - a. Product Data for Credit MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
    - 1) Include statement indicating costs for each product having recycled content.
  - b. Product Data for Credit EQ 4.1: For sealants, including printed statement of VOC content.
3. Samples: For each exposed finish.
4. Performance Data: For installed products indicated to comply with design loads and other criteria, include structural analysis and other analytical data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Coordination Drawings: Drawn to scale and coordinating and showing the following:
  - a. Ceiling suspension members.
  - b. Method of attaching hangers to building structure.
  - c. Ceiling-mounted items.
  - d. Ceiling perimeter and penetrations through the ceiling; and trim and moldings.
6. Product test reports.



7. Evaluation reports.
8. Field quality-control reports.
9. Maintenance data.

F. Quality Assurance

1. Acoustical Testing Agency Qualifications: An independent testing laboratory or an NVLAP-accredited laboratory, with the experience and capability to conduct the testing indicated. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.
2. Surface-Burning Characteristics: Complying with ASTM E 1264 for Class A materials as determined by testing identical products according to ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
3. Seismic Standard: Provide acoustical metal pan ceilings designed and installed to withstand the effects of earthquake motions according to the following:
  - a. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.
  - b. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings - Seismic Zones 0-2."
  - c. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies - Seismic Zones 3 & 4."
  - d. IBC Standard for Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings.
  - e. SEI/ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."
4. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling

1. Deliver acoustical metal pans, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
2. Handle acoustical metal pans, suspension system components, and accessories carefully to avoid damaging units and finishes in any way.

## 1.2 PRODUCTS

A. Acoustical Metal Ceiling Pans

1. Acoustical Metal Pan Standard: Provide manufacturer's standard acoustical metal pans of configuration indicated that comply with ASTM E 1264 classifications as designated by types, acoustical ratings, and light reflectances unless otherwise indicated.
  - a. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface per ASTM E 795.
2. Sheet Metal Characteristics: For metal components exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, roughness, stains, or discolorations.
  - a. Aluminum Sheet: Roll-formed aluminum sheet, complying with ASTM B 209 (ASTM B 209M); alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
  - b. Steel Sheet: Commercial-quality, cold-rolled, carbon-steel sheet; stretcher leveled; with protective coating complying with ASTM C 635.



- 1) Recycled Content: Provide products made from steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
  - 2) Painted Finishes: Electrolytic zinc-coated steel complying with ASTM A 591/A 591M, 40Z (12G) coating, surface treatment as recommended by finish manufacturer for type of use and finish indicated.
  - 3) Chemical/Mechanical Finishes: Uncoated steel sheet complying with ASTM A 1008/A 1008M with luster or bright finish as required by finisher for applying electroplating or other metallic-finishing processes.
  - c. Stainless-Steel Sheet: Complying with ASTM A 240/A 240M, Type 304 **OR** Type 430, **as directed**.
3. Sound-Absorbent Fabric Layer: Provide fabric layer, sized to fit concealed surface of pan, and consisting of black, nonwoven, nonflammable, sound-absorbent material with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing per ASTM E 84.
- a. Bond fabric layer to panels in the factory with manufacturer's standard nonflammable adhesive.
4. Sound-Absorbent Pads: Provide width and length to completely fill concealed surface of pan, with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing per ASTM E 84, and to comply with the following requirements:
- a. Plastic Sheet-Wrapped Mineral-Fiber Insulation: Pads consisting of nonrigid, PVC plastic sheet encapsulating unfaced mineral-fiber insulation complying with ASTM C 553, Type I, II, or III, and as follows:
    - 1) Mineral-Fiber Type and Thickness: Glass fiber; 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 3 inches (76 mm), **as directed**.
    - 2) Mineral-Fiber Density: 3/4 lb/cu. ft. (12 kg/cu. m) **OR** 1 lb/cu. ft. (16 kg/cu. m) **OR** 1-1/2 lb/cu. ft. (24 kg/cu. m), **as directed**.
    - 3) Plastic Sheet Thickness and Color: Not less than 0.003 inch (0.076 mm); clear **OR** flat black **OR** white, **as directed**.
  - b. Unwrapped, Glass-Fiber Insulation: Black coated, unfaced, complying with ASTM C 553, Type I, II, or III; not less than 1-lb/cu. ft. (16-kg/cu. m) density; treated to be nondusting; and as follows:
    - 1) Thickness: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
  - c. Spacer Grids: Provide manufacturer's standard aluminum **OR** galvanized-steel, **as directed**, grid units that provide an air cushion between metal pans and insulation pads and that act to improve sound absorption.
  - d. Sound Attenuation Panels: Provide manufacturer's standard aluminum **OR** galvanized-steel, **as directed**, unperforated metal backing unit that acts as a sound-attenuating pan to reduce the travel of sound through ceiling plenum into adjoining rooms.
    - 1) Sound-Absorbent Pads: Provide secondary sound-absorbent pads, same as specified for primary pads, for placement over sound attenuation pan to reduce plenum sound.
- B. Aluminum Pans For Acoustical Metal Pan Ceiling
1. Classification: Units complying with ASTM E 1264 for Type VII, perforated aluminum facing (pan) with mineral- or glass-fiber-base backing **OR** Type XX, other types described as perforated aluminum facing (pan) units with sound-absorbent fabric backing **OR** Type XX, other types described as unperforated aluminum facing (pan) units, **as directed**.
    - a. Pattern: Pattern A (perforated, regularly spaced large holes), arranged in diagonal **OR** parallel, **as directed**, alignment to pan edge with uniform perforations of dimension, holes per square foot or inch, and percent open area as indicated by product designation **OR** selected from manufacturer's full range, **as directed**.  
**OR**



Pattern: Pattern C (perforated, small holes) regularly spaced, with uniform perforations of dimension, holes per square foot or inch, and percent open area as specified by product designation **OR** selected from manufacturer's full range, **as directed**.

2. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.
  - a. Lay-in Pans: Formed to set in exposed suspension grid.
  - b. Clip-in Pans: Designed to clip-in and be securely retained in exposed suspension grid by formed edges or accessory clips.
  - c. Snap-in Pans: Designed with dimples or continuous beads on flanges for snap-in, secure engagement with concealed suspension system.
  - d. Torsion-Spring-Hinged Pans: Designed to be securely retained in preslotted exposed suspension grid by torsion springs.
3. Pan Thickness: Not less than 0.020 inch (0.5 mm) **OR** 0.025 inch (0.6 mm) **OR** 0.032 inch (0.8 mm) **OR** 0.040 inch (1.0 mm), **as directed**.
4. Pan Edge Detail: Square **OR** Beveled **OR** Reveal **OR** Manufacturer's standard edge detail, **as directed**.  
**OR**  
Pan Joint Detail: Butt **OR** Wide reveal, not less than 15/16 inch (24 mm) wide **OR** Narrow reveal, not greater than 9/16 inch (15 mm) wide **OR** Flush narrow reveal, not greater than 9/16 inch (15 mm) wide, **as directed**.
5. Pan Size: 12 by 12 inches (305 by 305 mm) **OR** 12 by 24 inches (305 by 610 mm) **OR** 12 by 36 inches (305 by 915 mm) **OR** 24 by 24 inches (610 by 610 mm) **OR** 24 by 48 inches (610 by 1220 mm) **OR** 24 by 60 inches (610 by 1525 mm) **OR** 30 by 30 inches (760 by 760 mm) **OR** 30 by 60 inches (760 by 1525 mm) **OR** As indicated on Drawings, **as directed**.
6. Scoring: Score pans at intervals to appear as 12-by-12-inch (305-by-305-mm) ceiling units.
7. Pan Face Finish: Mill **OR** Lacquered mill **OR** Clear anodized **OR** Clear mirror-anodized **OR** Painted white **OR** Painted to match color indicated by product designation **OR** Painted to match sample **OR** Painted in color selected from manufacturer's full range **OR** Bright-reflective metallic finish selected from manufacturer's full range, **as directed**.
8. LR: Not less than 0.70 **OR** 0.75, **as directed**.
9. NRC: Not less than 0.60 **OR** 0.65 **OR** 0.70 **OR** 0.75 **OR** 0.80 **OR** 0.85 **OR** 0.90 **OR** 0.95, **as directed**.
10. CAC: Not less than 35 **OR** 40 **OR** 45, **as directed**.

#### C. Steel Pans For Acoustical Metal Pan Ceiling

1. Classification: Units complying with ASTM E 1264 for Type V, perforated steel facing (pan) with mineral- or glass-fiber-base backing **OR** Type XX, other types described as perforated steel facing (pan) units with sound-absorbent fabric backing **OR** Type XX, other types described as unperforated steel facing (pan) units, **as directed**.
  - a. Pattern: Pattern A (perforated, regularly spaced large holes), arranged in diagonal **OR** parallel, **as directed**, alignment to pan edge with uniform perforations of dimension, holes per square foot or inch, and percent open area as indicated by product designation **OR** selected from manufacturer's full range, **as directed**.  
**OR**  
Pattern: Pattern C (perforated, small holes) regularly spaced, with uniform perforations of dimension, holes per square foot or inch, and percent open area as specified by product designation **OR** selected from manufacturer's full range, **as directed**.
2. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.
  - a. Lay-in Pans: Formed to set in exposed suspension grid.
  - b. Clip-in Pans: Designed to clip-in and be securely retained in exposed suspension grid by formed edges or accessory clips.
  - c. Snap-in Pans: Designed with dimples or continuous beads on flanges for snap-in, secure engagement with concealed suspension system.



- d. Torsion-Spring-Hinged Pans: Designed to be securely retained in preslotted exposed suspension grid by torsion springs.
3. Pan Thickness: Not less than 0.010-inch (0.25-mm) **OR** 0.020-inch (0.5-mm) **OR** 0.024-inch (0.6-mm) **OR** 0.030-inch (0.75-mm) **OR** 0.036-inch (0.9-mm), **as directed**, nominal thickness.
4. Pan Edge Detail: Square **OR** Beveled **OR** Reveal **OR** Manufacturer's standard edge detail, **as directed**.  
**OR**  
Pan Joint Detail: Butt **OR** Wide reveal, not less than 15/16 inch (24 mm) wide **OR** Narrow reveal, not greater than 9/16 inch (15 mm) wide **OR** Flush narrow reveal, not greater than 9/16 inch (15 mm) wide, **as directed**.
5. Pan Size: 12 by 12 inches (305 by 305 mm) **OR** 12 by 24 inches (305 by 610 mm) **OR** 12 by 36 inches (305 by 915 mm) **OR** 24 by 24 inches (610 by 610 mm) **OR** 24 by 48 inches (610 by 1220 mm) **OR** 24 by 60 inches (610 by 1525 mm) **OR** 30 by 30 inches (760 by 760 mm) **OR** 30 by 60 inches (760 by 1525 mm) **OR** As indicated on Drawings, **as directed**.
6. Scoring: Score pans at intervals to appear as 12-by-12-inch (305-by-305-mm) ceiling units.
7. Pan Face Finish: Painted white **OR** Painted to match color indicated by product designation **OR** Painted to match sample **OR** Painted in color selected from manufacturer's full range **OR** Plated with metallic finish, as selected from manufacturer's full range **OR** Bright-reflective metallic finish selected from manufacturer's full range, **as directed**.
8. LR: Not less than 0.70 **OR** 0.75, **as directed**.
9. NRC: Not less than 0.60 **OR** 0.65 **OR** 0.70 **OR** 0.75 **OR** 0.80 **OR** 0.85 **OR** 0.90 **OR** 0.95, **as directed**.
10. CAC: Not less than 35 **OR** 40 **OR** 45, **as directed**.

#### D. Stainless-Steel Pans For Acoustical Metal Pan Ceiling

1. Classification: Units complying with ASTM E 1264 for Type VI, perforated stainless-steel facing (pan) with mineral- or glass-fiber-base backing **OR** Type XX, other types described as perforated stainless-steel facing (pan) units with sound-absorbent fabric backing **OR** Type XX, other types described as unperforated stainless-steel facing (pan) units, **as directed**.
  - a. Pattern: Pattern A (perforated, regularly spaced large holes), arranged in parallel alignment to pan edge with uniform perforations of 0.109-inch (2.8-mm) diameter, 1800 holes/sq. ft. or inch, and 11.8 percent open area.
2. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.
  - a. Lay-in Pans: Formed to set in exposed suspension grid.
  - b. Clip-in Pans: Designed to clip-in and be securely retained in exposed suspension grid by formed edges or accessory clips.
  - c. Snap-in Pans: Designed with dimples or continuous beads on flanges for snap-in, secure engagement with concealed suspension system.
  - d. Torsion-Spring-Hinged Pans: Designed to be securely retained in preslotted exposed suspension grid by torsion springs.
3. Pan Thickness: Not less than 0.019 inch (0.5 mm) **OR** 0.025 inch (0.65 mm) **OR** 0.030 inch (0.76 mm), **as directed**.
4. Pan Edge Detail: Square **OR** Beveled **OR** Reveal **OR** Manufacturer's standard edge detail, **as directed**.  
**OR**  
Pan Joint Detail: Butt **OR** Wide reveal, not less than 15/16 inch (24 mm) wide **OR** Narrow reveal, not greater than 9/16 inch (15 mm) wide **OR** Flush narrow reveal, not greater than 9/16 inch (15 mm) wide, **as directed**.
5. Pan Size: 12 by 12 inches (305 by 305 mm) **OR** 12 by 24 inches (305 by 610 mm) **OR** 12 by 36 inches (305 by 915 mm) **OR** 24 by 24 inches (610 by 610 mm) **OR** 24 by 48 inches (610 by 1220 mm) **OR** 30 by 30 inches (760 by 760 mm) **OR** As indicated on Drawings, **as directed**.
6. Scoring: Score pans at intervals to appear as 12-by-12-inch (305-by-305-mm) ceiling units.
7. Pan Face Finish: Brushed, directional polish **OR** Satin, directional polish **OR** Mirrorlike reflective, nondirectional polish, **as directed**.



8. NRC: Not less than 0.60 **OR** 0.65 **OR** 0.70 **OR** 0.75 **OR** 0.80 **OR** 0.85 **OR** 0.90 **OR** 0.95, **as directed**.
9. CAC: Not less than 35 **OR** 40 **OR** 45, **as directed**.

E. Metal Suspension Systems

1. Recycled Content: Provide products made from steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Metal Suspension System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C 635 requirements.
3. Suspension Systems: Provide systems complete with carriers, runners, splice sections, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, and other suspension components required to support ceiling units and other ceiling-supported construction.
4. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
  - a. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
    - 1) Type: Cast-in-place **OR** Postinstalled expansion **OR** Postinstalled bonded, **as directed**, anchors.
    - 2) Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
    - 3) Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.
    - 4) Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.
  - b. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.
5. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
  - a. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
  - b. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
  - c. Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.
  - d. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C 635, Table 1, Direct Hung will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) **OR** 0.135-inch- (3.5-mm-), **as directed**, diameter wire.
6. Hanger Rods **OR** Flat Hangers, **as directed**: Mild steel, zinc coated or protected with rust-inhibitive paint.
7. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1.0-mm-) thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.
8. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
9. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
10. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical metal pans in place.
11. Hold-Down Clips: Manufacturer's standard hold-down clips spaced to secure acoustical metal pans in place to molding and trim at perimeter **OR** at each pan, **as directed**.



12. Exposed Metal Edge Moldings and Trim: Provide exposed members as indicated or as required to comply with seismic requirements of authorities having jurisdiction, to conceal edges of and penetrations through ceiling, to conceal edges of pans and runners, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching acoustical metal pan ceiling units, unless otherwise indicated.
    - a. For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.
- F. Direct-Hung, Standard-Grid, Metal Suspension System For Acoustical Metal Pan Ceiling
1. Suspension System: For clip-in **OR** lay-in **OR** torsion-spring, **as directed**, pans.
  2. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytic zinc-coated or hot-dip galvanized according to ASTM A 653/A 653M, G30 (Z90) coating designation, with prefinished, cold-rolled, 15/16-inch- (24-mm-) wide sheet metal caps on flanges.
    - a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
    - b. End Condition of Cross Runners: Override (stepped) **OR** Butt-edge, **as directed**, type.
    - c. Face Design: Flat, flush.
    - d. Cap Material: Steel **OR** Aluminum, **as directed**, cold-rolled sheet.
    - e. Cap Finish: Painted white **OR** Painted in color as selected from manufacturer's full range **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match color of metal pan **OR** Plated with metallic finish, as selected from manufacturer's full range **OR** Plated with metallic finish indicated by manufacturer's designation **OR** Natural finish for aluminum, **as directed**.
  3. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytic zinc-coated or hot-dip galvanized according to ASTM A 653/653M, G30 (Z90) coating designation, with prefinished, cold-rolled, 9/16-inch- (15-mm-) wide sheet metal caps on flanges.
    - a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
    - b. End Condition of Cross Runners: Override (stepped) **OR** Butt-edge, **as directed**, type.
    - c. Face Design: Flat, flush **OR** Flanges formed with an integral center reveal, **as directed**.
    - d. Cap Material: Steel **OR** Aluminum, **as directed**, cold-rolled sheet.
    - e. Cap Finish: Painted white **OR** Painted in color as selected from manufacturer's full range **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match color of metal pan **OR** Plated with metallic finish, as selected from manufacturer's full range **OR** Plated with metallic finish indicated by manufacturer's designation **OR** Natural finish for aluminum, **as directed**.
  4. Narrow-Face, Uncapped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytic zinc-coated or hot-dip galvanized, to produce structural members with 9/16-inch- (15-mm-) wide faces.
    - a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
    - b. Face Design: With 1/8-inch- (3.2-mm-) wide, slotted, box-shaped flange **OR** With 1/4-inch- (6.35-mm-) wide, slotted, box-shaped flange, **as directed**.
    - c. Face Finish: Painted white **OR** in color as selected from manufacturer's full range **OR** to match color indicated by manufacturer's designation **OR** to match color of metal pan, **as directed**.
  5. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, hot-dip galvanized according to ASTM A 653/A 653M, G60 (Z180) coating designation, with prefinished, cold-rolled, 15/16-inch- (24-mm-) wide aluminum caps on flanges.
    - a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
    - b. Face Design: Flat, flush.
    - c. Face Finish: Painted white **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match color of acoustical unit **OR** Natural finish, **as directed**.
  6. Wide-Face, Capped, Double-Web, Stainless-Steel Suspension System: Main and cross runners roll formed from and capped with Type 304 or 316 stainless-steel sheet, with prefinished, cold-rolled, 15/16-inch- (24-mm-) wide stainless-steel caps on flanges.



- a. Structural Classification: Intermediate-duty system.
  - b. Face Design: Flat, flush.
7. Suspension System for Torsion-Spring Metal Pans: Provide runners with factory-cut slots fabricated to accept torsion-spring attachment.
- G. Metal Suspension System For Acoustical Snap-In Metal Pan Ceiling
1. Indirect-Hung, Snap-Tee **OR** Bar, **as directed**, System: Designed to support metal pans that snap into main runners, consisting of main runners connected to carrying channels that are attached by hangers to building structure, and complying with the following requirements:
    - a. Main Runners: Formed from the following metal:
      - 1) Aluminum Sheet: Alloy and temper recommended by aluminum producer and finisher for type of use indicated and manufacturer's standard finish, complying with ASTM B 209 (ASTM B 209M).
      - 2) Electrolytic Zinc-Coated Steel Sheet: ASTM A 591/A 591M, with not less than 80Z (24G) zinc coating.
      - 3) Hot-Dip Galvanized Steel: ASTM A 653/A 653M, not less than G60 (Z180) zinc coating.
      - 4) Stainless-Steel Sheet: ASTM A 666, Type 302 or 304, stretcher leveled, with cold-rolled mill finish.
      - 5) Metal Sheet: Metal as standard with ceiling system manufacturer with factory-applied protective finish complying with ASTM C 635.
    - b. Carrying Channels: Same member and metal as indicated for main runners.  
**OR**  
Carrying Channels: Cold-rolled steel, not less than 0.060-inch (1.5-mm) nominal thickness of base (uncoated) metal and 7/16-inch- (11-mm-) wide flanges, protected with rust-inhibitive paint **OR** hot-dip galvanized according to ASTM A 653/A 653M, G60 (Z180) coating designation, **as directed**, and as follows:
      - 1) Depth and Weight: 1-1/2 inches and 475 lb/1000 feet (38 mm and 215 kg/305 m) **OR** 2 inches and 590 lb/1000 feet (51 mm and 268 kg/305 m), **as directed**.
    - c. Exterior Bracing Channels and Angles: Cold-rolled steel, hot-dip galvanized to comply with ASTM A 653/A 653M, G60 (Z180) coating designation; size and profile as required to withstand wind load.
  2. Direct-Hung, Snap-Tee **OR** Bar, **as directed**, System: Designed to support metal pans that snap into main runners, consisting of main runners supported by hangers attached directly to building structure, and complying with the following requirements:
    - a. Hangers: Angles or channels, as standard with ceiling system manufacturer, formed from same metal as main runners.
    - b. Main Runners: Rolled aluminum sheet; alloy and temper recommended by aluminum producer and finisher for type of use indicated and manufacturer's standard finish, complying with ASTM B 209 (ASTM B 209M).
  3. Access Panels: For access at locations indicated, provide acoustical snap-in metal pan ceiling units, accessible by key or tool **OR** two access knobs; place one access knob at each end of panel near corners, **as directed**.
    - a. Access Key or Tool: Provide manufacturer' standard key or tool for opening access panels; one **OR** two, **as directed**.
- H. Acoustical Sealant
1. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
  2. Acoustical Sealant for Concealed Joints: Manufacturer's standard nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant, with a VOC content of 250 g/L or



less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), recommended for sealing interior concealed joints to reduce airborne sound transmission.

- I. General Finish Requirements
  1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
    - a. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.
  2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
  3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- J. Aluminum Finishes
  1. Mill Finish: AA-M10C10 (Mechanical Finish: as fabricated, unspecified; Chemical Finish: chemically cleaned).
  2. Lacquered Mill Finish: AA-M10C10R1x (Mechanical Finish: as fabricated, unspecified; Chemical Finish: chemically cleaned; Organic Coating: as specified below).
    - a. Organic Coating: Manufacturer's standard clear organic coating.
  3. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
  4. Clear Mirror Anodic Finish: AA-M21C12A212, 0.005 mm or thicker.
  5. Color-Coated Finish: Manufacturer's standard powder-coat, **as directed**, baked paint complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.
  6. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.
- K. Galvanized-Steel Sheet Finishes
  1. Color-Coated Finish: Manufacturer's standard powder-coat, **as directed**, baked paint complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.
- L. Steel Sheet Finishes
  1. Electroplated Finish: Electroplating process complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, and minimum thickness to produce a coating uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unplated areas, and other visible defects.
  2. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.
- M. Stainless-Steel Finishes
  1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
  2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
    - a. Run grain of directional finishes with long dimension of each piece.
    - b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.



### 1.3 EXECUTION

#### A. Preparation

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

#### B. Installation

1. Install acoustical metal pan ceilings to comply with ASTM C 636 **OR** IBC Standard, **as directed**, and seismic requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
2. Suspend ceiling hangers from building's structural members and as follows:
  - a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
  - b. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  - c. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
  - d. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.  
**OR**  
Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved.
  - e. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
  - f. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
  - g. Do not attach hangers to steel deck tabs.
  - h. Do not attach hangers to steel roof deck. Attach hangers to structural members.
  - i. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
  - j. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
3. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
4. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical metal pans.
  - a. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
  - b. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
  - c. Do not use exposed fasteners, including pop rivets, on moldings and trim.
5. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.



6. Cut acoustical metal pan units for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness exceeding referenced standards for stretcher-leveled metal sheet.
  7. Install acoustical metal pans in coordination with suspension system and exposed moldings and trim.
    - a. For lay-in square-edge pans, install pans with edges fully hidden from view by flanges of suspension system runners and moldings.
    - b. For lay-in reveal-edge pans on suspension system runners, install pans with bottom of reveal in firm contact with top surface of runner flanges.
    - c. For lay-in reveal-edge pans on suspension system members with box-shaped flanges, install pans with reveal surfaces in firm contact with suspension system surfaces and panel faces flush with bottom face of runners.
    - d. For clip-in **OR** torsion-spring-hinged, **as directed**, pans, position pans according to manufacturer's written instructions.
    - e. For snap-in pans, fit adjoining units to form flush, tight joints.
    - f. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated.
    - g. Fit adjoining units to form flush, tight joints.
    - h. Install directionally patterned or textured metal pans in directions indicated.
    - i. Install sound-absorbent fabric layers in perforated metal pans.
    - j. Install sound-absorbent pads in perforated metal pans over metal spacer grids, **as directed**.
  8. Install sound attenuation panels in areas indicated by reflected ceiling plans or room finish schedules. Lay panels directly on ceiling system and close major openings to form complete coverage in required areas. Lay second sound-absorbent pads on sound attenuation panels.
  9. Install hold-down clips where indicated.
- C. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
  2. Tests and Inspections: Testing and inspecting of completed installations of acoustical panel ceiling hangers and anchors and fasteners shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.
    - a. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed.
      - 1) Within each test area, testing agency will select 1 of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select one of every 2 postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
      - 2) When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
  3. Acoustical panel ceiling hangers and anchors and fasteners will be considered defective if they do not pass tests and inspections.
  4. Prepare test and inspection reports.
- D. Cleaning
1. Clean exposed surfaces of acoustical metal pan ceilings, including trim and edge moldings after removing strippable, temporary protective covering, if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.



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END OF SECTION 09 54 23 00



## SECTION 09 54 23 00a - LINEAR METAL CEILINGS

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. Section includes strip linear metal pans and suspension systems for ceilings.

#### C. Definitions

1. LR: Light Reflectance coefficient.
2. NRC: Noise Reduction Coefficient.

#### D. Performance Requirements

1. Structural Performance: Exterior linear metal ceilings shall withstand exterior exposure and the effects of gravity loads and the following loads and stresses without showing permanent deformation of ceiling system components including pans and suspension system; noise or metal fatigue caused by vibration, deflection, and displacement of ceiling units; or permanent damage to fasteners and anchors.
  - a. Wind Load: Uniform pressure of 20 lbf/sq. ft. (960 Pa) **OR** of 30 lbf/sq. ft. (1436 Pa) **OR** as indicated on Drawings, **as directed**, acting inward or outward.
2. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), **as directed**, material surfaces.

#### E. Submittals

1. Product Data: For each type of product indicated.
2. Performance Data: For installed products indicated to comply with design loads and other criteria, include structural analysis and other analytical data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Samples: For each exposed finish.
4. Coordination Drawings: Drawn to scale and coordinating and showing the following:
  - a. Linear pattern.
  - b. Joint pattern.
  - c. Ceiling suspension members.
  - d. Method of attaching hangers to building structure.
  - e. Ceiling-mounted items.
  - f. Ceiling perimeter and penetrations through ceiling; trim and moldings.
5. Product test reports.
6. Evaluation reports.
7. Maintenance data.

#### F. Quality Assurance

1. Acoustical Testing Agency Qualifications: An independent testing laboratory or an NVLAP-accredited laboratory.
2. Surface-Burning Characteristics: Complying with ASTM E 1264 for Class A materials, as determined by testing identical products according to ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.



3. Seismic Standard: Comply with 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. SEI/ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

G. Delivery, Storage, And Handling

1. Deliver linear metal pans, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
2. Handle linear metal pans, suspension system components, and accessories carefully to avoid damaging units and finishes in any way.

## 1.2 PRODUCTS

A. Linear Metal Ceiling Pans

1. Acoustical Metal Pan Standard: Provide manufacturer's standard linear metal pans of configuration indicated that comply with ASTM E 1264.
  - a. Mounting Method for Measuring NRC: Type E-400.
2. Sheet Metal Characteristics: For metal components exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, roughness, stains, or discolorations.
  - a. Aluminum Sheet: Roll-formed aluminum sheet, complying with ASTM B 209 (ASTM B 209M); alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
  - b. Steel Sheet: Commercial-quality, cold-rolled, carbon-steel sheet; stretcher leveled; with protective coating complying with ASTM C 635.
  - c. Steel Sheet: Commercial-quality, cold-rolled, carbon-steel sheet; stretcher leveled and ASTM A 591/A 591M, 40Z (12G) coating for painted finish **OR** ASTM A 1008/A 1008M for electroplating, **as directed**; with protective coating complying with ASTM C 635 and recommended by finisher for finish indicated.
  - d. Stainless-Steel Sheet: Complying with ASTM A 240/A 240M, Type 304 **OR** Type 430, **as directed**.
3. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated to snap on and be securely retained on carriers without separate fasteners, and finished to comply with requirements indicated.
4. Pan Splices: Construction same as pans, in lengths 8 to 12 inches (200 to 300 mm); with manufacturer's standard finish.
5. End Caps: Metal matching pans **OR** Plastic **OR** Manufacturer's standard material, **as directed**; fabricated to fit and conceal exposed ends of pans.
6. Filler Strips: Metal matching pans **OR** Plastic **OR** Manufacturer's standard material, **as directed**; fabricated to uninterruptedly close voids between pans.
7. Moldings and Trim: Provide manufacturer's standard moldings and trim for exposed members, and as indicated or required, for edges and penetrations of ceiling, around fixtures, at changes in ceiling height, and for other conditions; of same metal and finish as linear metal ceiling pans.



8. Sound-Absorbent Fabric Layer: Provide fabric layer, sized to fit concealed surface of pan, and consisting of black, nonwoven, nonflammable, sound-absorbent material with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing per ASTM E 84.
    - a. Bond fabric layer to pan in the factory with manufacturer's standard nonflammable adhesive.
  9. Sound-Absorbent Pads: Provide width and length to completely fill between carriers, joined at center of panel, with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing per ASTM E 84, and to comply with the following requirements:
    - a. Plastic Sheet-Wrapped Mineral-Fiber Insulation: Pads consisting of nonrigid, PVC plastic sheet encapsulating unfaced mineral-fiber insulation complying with ASTM C 553, Type I, II, or III, and as follows:
      - 1) Mineral-Fiber Type and Thickness: Glass fiber; 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 3 inches (76 mm), **as directed**.
      - 2) Mineral-Fiber Density: 3/4 lb/cu. ft. (12 kg/cu. m) **OR** 1 lb/cu. ft. (16 kg/cu. m) **OR** 1-1/2 lb/cu. ft. (24 kg/cu. m), **as directed**.
      - 3) Plastic Sheet Thickness and Color: Not less than 0.003 inch (0.076 mm); clear **OR** flat black **OR** white, **as directed**.
    - b. Unwrapped, Glass-Fiber Insulation: Black-coated, unfaced, glass-fiber insulation complying with ASTM C 553, Type I, II, or III, not less than 1-lb/cu. ft. (16-kg/cu. m) density, treated to be nondusting, and as follows:
      - 1) Thickness: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
- B. Metal Suspension Systems
1. Metal Suspension Systems Standard: Provide ceiling manufacturer's standard metal suspension systems of types and finishes indicated that comply with applicable ASTM C 635 requirements.
  2. Suspension Systems: Provide systems complete with carriers, splice sections, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, fixture adapters, and other suspension components required to support ceiling units and other ceiling-supported construction.
  3. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, Direct Hung, unless otherwise indicated.
    - a. Cast-in-Place and Postinstalled 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 service condition (mild).
      - 3) Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchors.
      - 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.
  4. Wire Hangers, Braces, and Ties: Provide wire complying with the following requirements:
    - a. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
    - b. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
    - c. Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.



- d. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C 635, Table 1, Direct Hung will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) **OR** 0.135-inch- (3.5-mm-), **as directed**, diameter wire.
5. Hanger Rods **OR** Flat Hangers, **as directed**: Mild steel, zinc coated or protected with rust-inhibitive paint.
  6. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed from 0.04-inch- (1.0-mm-) thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.
  7. Carriers: Factory finished with matte-black baked finish, **as directed**.
    - a. Main Carriers: Aluminum, not less than 0.240-inch (6.0-mm) rolled sheet, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, complying with ASTM B 209 (ASTM B 209M).
    - b. Main Carriers: Steel, not less than 0.0209-inch (0.53-mm) nominal thickness, cold-rolled sheet, with factory-applied protective coating, complying with ASTM C 635.
      - 1) Electrolytic Zinc-Coated Steel: ASTM A 591/A 591M, not less than 80Z (24G), **as directed**, zinc coating.
      - 2) Hot-Dip Galvanized Steel: ASTM A 653/A 653M, not less than G60 (Z180), **as directed**, zinc coating.
    - c. Adaptable Carriers: Manufacturer's standard carriers for direct attachment to existing suspended tees.
    - d. Flexible Radial Carriers: Manufacturer's standard radial carriers.
    - e. Expansion Carriers: Manufacturer's standard carriers allowing for irregularities or other unusual space conditions.
  8. Carrier Splices: Same metal, profile, and finish as indicated for carriers.
  9. Stabilizer Channels, Tees, and Bars: Manufacturer's standard components for stabilizing main carriers at regular intervals and at light fixtures, air-distribution equipment, access doors, and other equipment; spaced as standard with manufacturer for use indicated; and factory finished with matte-black baked finish.
  10. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
  11. Exterior Bracing Channels and Angles: Cold-rolled steel, hot-dip galvanized to comply with ASTM A 653/A 653M, G60 (Z180) coating designation; size and profile as required to withstand wind load.
  12. Hold-Down Clips: Manufacturer's standard hold-down clips spaced as standard with manufacturer.
  13. Edge Moldings and Trim: Provide exposed members as indicated or required to comply with seismic requirements of authorities having jurisdiction, to conceal edges of penetrations through ceiling, to conceal ends of pans and carriers, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching linear metal pans or extruded plastic unless otherwise indicated.
    - a. For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.
- C. Aluminum Pans And Suspension System For Linear Metal Ceiling
1. Aluminum Pans and Suspension System:
  2. Classification: Units complying with ASTM E 1264 for Type XIII, aluminum strips with mineral- or glass-fiber-base backing; Form 1, perforated **OR** Type XIII, aluminum strips with mineral- or glass-fiber-base backing; Form 2, unperforated **OR** Type XX, other types described as perforated aluminum strips with sound-absorbent fabric backing, **as directed**.
  3. Pan Thickness: Not less than 0.018 inch (0.46 mm) **OR** 0.022 inch (0.56 mm) **OR** 0.024 inch (0.6 mm) **OR** 0.025 inch (0.65 mm) **OR** 0.027 inch (0.7 mm) **OR** 0.032 inch (0.8 mm) **OR** 0.040 inch (1.0 mm), **as directed**.
  4. Pan Edge Detail: Beveled **OR** Square **OR** Round **OR** Manufacturer's standard edge detail, **as directed**.



5. Linear Module Width and Pan Face Width: 2-inch (51-mm) module width and 1-1/4-inch (32-mm) face width **OR** 4-inch (102-mm) module width and 3-1/4-inch (83-mm) face width **OR** 6-inch (152-mm) module width and 5-1/4-inch (133-mm) face width **OR** 8-inch (203-mm) module width and 7-1/4-inch (184-mm) face width **OR** 100-mm module width and 80-mm face width **OR** 200-mm module width and 180-mm face width **OR** 300-mm module width and 280-mm face width **OR** As indicated on Drawings, **as directed**.
6. Pan Depth: 5/8 inch (16 mm) deep **OR** 3/4 inch (19 mm) deep **OR** Not less than 1 to 1-1/2 inches (25 to 38 mm) deep **OR** 15 mm deep **OR** As indicated, **as directed**.
7. Pan Face Finish: Mill **OR** Lacquered mill **OR** Clear anodized **OR** Clear mirror-anodized **OR** Painted white **OR** Painted to match color indicated by product designation **OR** Painted to match sample **OR** Painted in color selected from manufacturer's full range **OR** High-performance organic coating in color selected from manufacturer's full range **OR** Bright-reflective finish selected from manufacturer's full range, **as directed**.
8. End Cap, Finish of Exposed Portions: Matte black **OR** To match pan **OR** Manufacturer's standard finish, **as directed**.
9. Filler Strip Design: Recessed **OR** Flush **OR** An integral extension of pan profile **OR** Expansion, for use with expansion carriers **OR** Slotted, for air diffusion, **as directed**.
10. Filler Strip, Finish of Exposed Portions: Matte black **OR** To match pan, **as directed**.
11. LR: Not less than 0.70 **OR** 0.75, **as directed**.
12. NRC: Not less than 0.65 **OR** 0.75 **OR** 0.95, **as directed**.
13. Suspension-System Main-Carrier Material: Aluminum **OR** Electrolytic zinc-coated steel **OR** Hot-dip galvanized steel **OR** Manufacturer's standard material and protective finish, **as directed**.

D. Steel Pans And Suspension System For Linear Metal Ceiling

1. Steel Pans and Suspension System:
2. Classification: Units complying with ASTM E 1264 for Type XIII, steel strips with mineral- or glass-fiber-base backing; Form 1, perforated **OR** Type XIII, steel strips with mineral- or glass-fiber-base backing; Form 2, unperforated **OR** Type XX, other types described as perforated steel strips with sound-absorbent fabric backing, **as directed**.
3. Pan Thickness: Not less than 0.015 inch (0.4 mm) **OR** 0.020 inch (0.5 mm) **OR** 0.024 inch (0.6 mm) **OR** 0.030 inch (0.75 mm), **as directed**.
4. Pan Edge Detail: Beveled **OR** Square **OR** Round **OR** Manufacturer's standard edge detail, **as directed**.
5. Linear Module Width and Pan Face Width: 2-inch (51-mm) module width and 1-1/4-inch (32-mm) face width **OR** 4-inch (102-mm) module width and 3-1/4-inch (83-mm) face width **OR** 6-inch (152-mm) module width and 5-1/4-inch (133-mm) face width **OR** 8-inch (203-mm) module width and 7-1/4-inch (184-mm) face width **OR** As indicated on Drawings, **as directed**.
6. Pan Depth: 5/8 inch (16 mm) deep **OR** 3/4 inch (19 mm) deep **OR** Not less than 1 to 1-1/2 inches (25 to 38 mm) deep **OR** 15 mm deep **OR** As indicated, **as directed**.
7. Pan Face Finish: Painted white **OR** Painted to match color indicated by product designation **OR** Painted to match sample **OR** Painted in color selected from manufacturer's full range **OR** Electroplated finish selected from manufacturer's full range, **as directed**.
8. End Cap, Finish of Exposed Portions: Matte black **OR** To match pan **OR** Manufacturer's standard finish, **as directed**.
9. Filler Strip Design: Recessed **OR** Flush **OR** An integral extension of pan profile **OR** Expansion, for use with expansion carriers **OR** Slotted, for air diffusion, **as directed**.
10. Filler Strip, Finish of Exposed Portions: Matte black **OR** To match pan, **as directed**.
11. LR: Not less than 0.70 **OR** 0.75, **as directed**.
12. NRC: Not less than 0.65 **OR** 0.75 **OR** 0.95, **as directed**.
13. Suspension-System Main-Carrier Material: Aluminum **OR** Electrolytic zinc-coated steel **OR** Hot-dip galvanized steel **OR** Manufacturer's standard material and protective finish, **as directed**.

E. Stainless-Steel Pans And Suspension System For Linear Metal Ceiling

1. Stainless-Steel Pans and Suspension System:
2. Classification: Units complying with ASTM E 1264 for Type XIII, stainless-steel strips with mineral- or glass-fiber-base backing; Form 1, perforated **OR** Type XIII, stainless-steel strips with



mineral- or glass-fiber-base backing; Form 2, unperforated **OR** Type XX, other types described as perforated stainless-steel strips with sound-absorbent fabric backing, **as directed**.

3. Pan Thickness: Not less than 0.016 inch (0.396 mm) **OR** 0.019 inch (0.475 mm), **as directed**.
4. Pan Edge Detail: Manufacturer's standard edge detail, **as directed**.
5. Linear Module Width and Pan Face Width: 2-inch (51-mm) module width and 1-1/4-inch (32-mm) face width **OR** 4-inch (102-mm) module width and 3-1/4-inch (83-mm) face width **OR** 6-inch (152-mm) module width and 5-1/4-inch (133-mm) face width **OR** 8-inch (203-mm) module width and 7-1/4-inch (184-mm) face width **OR** As indicated on Drawings, **as directed**.
6. Pan Depth: 5/8 inch (16 mm) deep **OR** As indicated, **as directed**.
7. Pan Face Finish: Brushed, directional polish **OR** Satin, directional polish **OR** Mirrorlike reflective, nondirectional polish, **as directed**.
8. End Cap, Finish of Exposed Portions: Matte black **OR** To match pan **OR** Manufacturer's standard finish, **as directed**.
9. Filler Strip Design: Recessed **OR** Flush **OR** An integral extension of pan profile **OR** Expansion, for use with expansion carriers **OR** Slotted, for air diffusion, **as directed**.
10. Filler Strip, Finish of Exposed Portions: Matte black **OR** To match pan, **as directed**.
11. NRC: Not less than 0.65 **OR** 0.75 **OR** 0.95, **as directed**.
12. Suspension-System Main-Carrier Material: Aluminum **OR** Electrolytic zinc-coated steel **OR** Hot-dip galvanized steel **OR** Manufacturer's standard material and protective finish, **as directed**.

#### F. Accessories

1. Access Panels: For access at locations indicated, provide door hinge assembly, retainer clip, and retainer bar, assembled with ceiling panels and carrier sections into access doors of required size, permitting upward or downward opening.

#### G. General Finish Requirements

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical 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.

#### H. Aluminum Finishes

1. Mill Finish: AA-M10C10.
2. Lacquered Mill Finish: AA-M10C10R1x with manufacturer's standard clear, organic coating.
3. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
4. Clear Mirror Anodic Finish: AA-M21C12A212, 0.005 mm or thicker.
5. Color-Coated Finish: Manufacturer's standard powder-coat baked paint finish complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.
6. High-Performance Organic Finish: 2-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
7. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.

#### I. Galvanized-Steel Sheet Finishes



1. Color-Coated Finish: Manufacturer's standard powder-coat baked paint finish complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

J. Steel Sheet Finishes

1. Electroplated Finish: Electroplating process complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, and minimum thickness to produce a coating uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unplated areas, and other visible defects.
2. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.

K. Stainless-Steel Finishes

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
  - a. Run grain of directional finishes with long dimension of each piece.
  - b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

### 1.3 EXECUTION

A. Installation

1. Comply with ASTM C 636 **OR** IBC Standard, **as directed**, and seismic requirement indicated, per manufacturer's written instructions and Cisca's "Ceiling Systems Handbook."
2. Suspend ceiling hangers from building's structural members and as follows:
  - a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
  - b. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  - c. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
  - d. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate to which hangers are attached and for type of hanger involved.
  - e. 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.
  - f. 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.
  - g. 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.
  - h. Do not attach hangers to steel deck tabs.
  - i. Do not attach hangers to steel roof deck. Attach hangers to structural members.
  - j. 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.



- k. 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 but 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 linear metal ceiling area and where necessary to conceal edges and ends of linear metal pans.
    - a. 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.
    - b. Do not use exposed fasteners, including pop rivets, on moldings and trim.
  5. Install suspension system carriers so they are aligned and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
  6. Cut linear metal pans for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness exceeding referenced standards for stretcher-leveled metal sheet.
  7. Install linear metal pans in coordination with suspension system and exposed moldings and trim.
    - a. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated.
    - b. Fit adjoining units to form flush, tight joints. Scribe and cut units for accurate fit at borders and around construction penetrating ceiling.
    - c. Install pans with butt joints using internal pan splices.
      - 1) Joint Configuration: Aligned **OR** Aligned, every other panel length **OR** Staggered a minimum of 12 inches (300 mm) **OR** Random **OR** As indicated, **as directed**.
    - d. Install directionally textured metal pans in directions indicated.
    - e. Where metal pan ends are visible, install end caps unless trim is indicated.
    - f. Install filler strips where indicated.
    - g. Install sound-absorbent fabric layers in perforated metal pans.
    - h. Install sound-absorbent pads at right angle to perforated metal pans so pads do not hang unsupported.
  8. Install hold-down clips where indicated.
- B. Cleaning
1. Clean exposed surfaces of linear metal ceilings, including trim and edge moldings after removing strippable, temporary protective covering if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.

END OF SECTION 09 54 23 00a



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
09 81 16 00	09 84 13 00	Acoustical Wall Panels

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## SECTION 09 84 13 00 - 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, AWWA C20, Interior Type A, fire-retardant treated, low-hygroscopic-type formulation. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Kiln-dry material after treatment to 5 to 10 percent moisture content.

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

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



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



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



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

### 1.3 EXECUTION

#### A. Installation

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



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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 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
09 85 00 00	09 28 13 00	Gypsum Board
09 85 00 00	09 23 13 00	Gypsum Board Renovation
09 85 00 00	09 28 13 00a	Gypsum Board Shaft-Wall Assemblies



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**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. Provide data on all finishing products, including VOC content.
2. Samples: For each finish and for each color and texture required. Submit two painted samples, illustrating selected colors and textures for each color and system selected. Submit on tempered hardboard, 8 x 10 inch in size.
3. Product List: Printout of current "MPI Approved Products List" for each product category specified in Part 1.2, with the proposed product highlighted.

**D. Quality Assurance**

1. MPI Standards:
  - a. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
  - b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated. For renovation projects, comply with requirements of "MPI Maintenance Repainting Manual" for products and paint systems indicated.

**E. Delivery, Storage, And Handling**

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

**F. Project Conditions**

1. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
2. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.
3. Provide lighting level of 80 ft candles measured mid-height at substrate surface.



## 1.2 PRODUCTS

### A. Paint, General

1. Conform to applicable code for flame and smoke rating requirements for products and finishes.
2. Conform to County of San Mateo Public Works Building Standards
  - a. Paint products shall not contain formaldehyde, aqueous ammonia, crystalline silica, or ethylene glycol. Total Volatile Organic Compounds (VOC) shall not exceed 2.9 pounds per gallon.
3. 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.
4. 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.
  - L. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified; commercial quality.
- 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.
6. Marks: Seal with shellac those which may bleed through surface finishes.
7. Impervious Surfaces: Remove mildew by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

#### 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 - 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 6.4.J.



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

END OF SECTION 09 91 13 00a



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## SECTION 09 91 13 00b - 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 00b



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
09 91 13 00	01 22 16 00	No Specification Required

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**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. Provide data on all finishing products, including VOC content.
2. Samples: For each finish and for each color and texture required. Submit two painted samples, illustrating selected colors and textures for each color and system selected. Submit on tempered hardboard, 8 x 10 inch in size.
3. Product List: Printout of current "MPI Approved Products List" for each product category specified in Part 1.2, with the proposed product highlighted.
4. LEED Submittal:
  - a. Product Data for Credit EQ 4.2: For paints, including printed statement of VOC content and chemical components.

## D. Quality Assurance

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

## E. Delivery, Storage, And Handling

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

## F. Project Conditions

1. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).



2. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.
3. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

## 1.2 PRODUCTS

### A. Paint, General

1. Conform to applicable code for flame and smoke rating requirements for products and finishes.
2. Conform to County of San Mateo Public Works Building Standards
  - a. Paint products shall not contain formaldehyde, aqueous ammonia, crystalline silica, or ethylene glycol. Total Volatile Organic Compounds (VOC) shall not exceed 2.9 pounds per gallon.
3. 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.
4. 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.
5. Pre-Treatment Wash Primers: VOC content of not more than 420 g/L.
6. 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.
7. 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.
- M. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified; commercial quality.

### 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. Uncoated Steel and Iron Surfaces to be Painted: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by hand wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Prime paint entire surface; spot prime after repairs.
11. Shop-Primed Steel Surfaces to be Finish Painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
12. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.
13. 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.
14. Gypsum Board Substrates: Fill minor defects with filler compound. Spot prime defects after repair. Do not begin paint application until finishing compound is dry and sanded smooth.
15. Plaster Substrates: Do not begin paint application until plaster is fully cured and dry.
16. Spray-Textured Ceiling Substrates: Do not begin paint application until surfaces are dry.
17. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.
18. Marks: Seal with shellac those which may bleed through surface finishes.
19. Impervious Surfaces: Remove mildew by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

#### 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:
    - a. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
    - b. Finish equipment, piping, conduit, and exposed duct work at all exterior areas in colors according to the color schedule.
    - c. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.
    - d. Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
      - 1) Mechanical Work:
        - a) Uninsulated metal piping.
        - b) Uninsulated plastic piping.
        - c) Pipe hangers and supports.
        - d) Tanks that do not have factory-applied final finishes.
        - e) Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
        - f) Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
        - g) Mechanical equipment that is indicated to have a factory-primed finish for field painting.
      - 2) Electrical Work:
        - a) Switchgear.
        - b) Panelboards.
        - c) Electrical equipment that is indicated to have a factory-primed finish for field painting.
- C. Field Quality Control
1. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
    - a. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
    - b. Testing agency will perform tests for compliance with product requirements.
    - c. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.
- D. Cleaning And Protection
1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.



2. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
3. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by the Owner, and leave in an undamaged condition.
4. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

#### E. Interior Painting Schedule

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



- 2) Topcoat: Interior concrete floor stain.
  - d. Clear Sealer System: MPI INT 3.2F.
    - 1) First Coat: Interior/exterior clear concrete floor sealer (solvent based).
    - 2) Topcoat: Interior/exterior clear concrete floor sealer (solvent based).
  - e. Water-Based Clear Sealer System: MPI INT 3.2G.
    - 1) First Coat: Interior/exterior clear concrete floor sealer (water based).
    - 2) Topcoat: Interior/exterior clear concrete floor sealer (water based).
3. Clay-Masonry Substrates:
- a. Latex System: MPI INT 4.1A.
    - 1) Prime Coat: Interior latex matching topcoat.
    - 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
    - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
  - b. Alkyd System: MPI INT 4.1D.
    - 1) Prime Coat: Interior latex primer/sealer.
    - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
    - 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
  - c. Latex Aggregate System: MPI INT 4.1B.
    - 1) Prime Coat: As recommended in writing by topcoat manufacturer.
    - 2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
    - 3) Topcoat: Latex stucco and masonry textured coating.
  - d. Institutional Low-Odor/VOC Latex System: MPI INT 4.1M.
    - 1) Prime Coat: Institutional low-odor/VOC interior latex matching topcoat.
    - 2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
    - 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
  - e. High-Performance Architectural Latex System: MPI INT 4.1L.
    - 1) Prime Coat: High-performance architectural latex matching topcoat.
    - 2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
    - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
4. CMU Substrates:
- a. Latex System: MPI INT 4.2A.
    - 1) Prime Coat: Interior/exterior latex block filler.
    - 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
    - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
  - b. Alkyd System: MPI INT 4.2C.
    - 1) Prime Coat: Interior/exterior latex block filler.
    - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
    - 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
  - c. Alkyd Over Latex Sealer System: MPI INT 4.2N.
    - 1) Prime Coat: Interior/exterior latex block filler.
    - 2) Sealer Coat: Interior latex primer/sealer.
    - 3) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
    - 4) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
  - d. Institutional Low-Odor/VOC Latex System: MPI INT 4.2E.
    - 1) Prime Coat: Interior/exterior latex block filler.
    - 2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.



- 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
- e. High-Performance Architectural Latex System: MPI INT 4.2D.
  - 1) Prime Coat: Interior/exterior latex block filler.
  - 2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
  - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
5. Steel Substrates:
  - a. Quick-Drying Enamel System: MPI INT 5.1A.
    - 1) Prime Coat: Quick-drying alkyd metal primer.
    - 2) Intermediate Coat: Quick-drying enamel matching topcoat.
    - 3) Topcoat: Quick-drying enamel (semigloss) **OR** (high gloss), **as directed**.
  - b. Water-Based Dry-Fall System: MPI INT 5.1C.
    - 1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
    - 2) Topcoat: Latex dry fog/fall **OR** Waterborne dry fall, **as directed**.
  - c. Alkyd Dry-Fall System: MPI INT 5.1D.
    - 1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
    - 2) Topcoat: Interior alkyd dry fog/fall.
  - d. Latex Over Alkyd Primer System: MPI INT 5.1Q.
    - 1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
    - 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
    - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
  - e. Alkyd System: MPI INT 5.1E.
    - 1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
    - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
    - 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
  - f. Aluminum Paint System: MPI INT 5.1M.
    - 1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
    - 2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.
    - 3) Topcoat: Aluminum paint.
  - g. Institutional Low-Odor/VOC Latex System: MPI INT 5.1S.
    - 1) Prime Coat: Rust-inhibitive primer (water based).
    - 2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
    - 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
  - h. High-Performance Architectural Latex System: MPI INT 5.1R.
    - 1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
    - 2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
    - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
6. Galvanized-Metal Substrates:
  - a. Water-Based Dry-Fall System: MPI INT 5.3H.
    - 1) Prime Coat: Waterborne dry fall.
    - 2) Topcoat: Waterborne dry fall.
  - b. Alkyd Dry-Fall System: MPI INT 5.3F.
    - 1) Prime Coat: Cementitious galvanized-metal primer.
    - 2) Topcoat: Interior alkyd dry fog/fall.
  - c. Latex System: MPI INT 5.3A.
    - 1) Prime Coat: Cementitious galvanized-metal primer.
    - 2) Intermediate Coat: Interior latex matching topcoat.



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



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



- 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
10. Wood Panel Substrates: Including painted plywood, medium-density fiberboard, and hardboard.
  - a. Latex System: MPI INT 6.4R.
    - 1) Prime Coat: Interior latex-based wood primer.
    - 2) Intermediate Coat: Interior latex matching topcoat.
    - 3) Topcoat: Interior latex (semigloss) **OR** (gloss), **as directed**.
  - b. Latex Over Alkyd Primer System: MPI INT 6.4A.
    - 1) Prime Coat: Interior alkyd primer/sealer.
    - 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
    - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
  - c. Alkyd System: MPI INT 6.4B.
    - 1) Prime Coat: Interior alkyd primer/sealer.
    - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
    - 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
  - d. Institutional Low-Odor/VOC Latex System: MPI INT 6.4T.
    - 1) Prime Coat: Interior latex-based wood primer.
    - 2) Intermediate Coat : Institutional low-odor/VOC interior latex matching topcoat.
    - 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
  - e. High-Performance Architectural Latex System: MPI INT 6.4S.
    - 1) Prime Coat: Interior latex-based wood primer.
    - 2) Intermediate Coat: High-performance architectural latex matching topcoat.
    - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
11. Dimension Lumber Substrates, Nontraffic Surfaces: Including exposed joists and exposed beams.
  - a. Latex System: MPI INT 6.2D.
    - 1) Prime Coat: Interior latex-based wood primer.
    - 2) Intermediate Coat: Interior latex matching topcoat.
    - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
  - b. Latex Over Alkyd Primer System: MPI INT 6.2A.
    - 1) Prime Coat: Interior alkyd primer/sealer.
    - 2) Intermediate Coat : Interior latex matching topcoat.
    - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
  - c. Alkyd System: MPI INT 6.2C.
    - 1) Prime Coat: Interior alkyd primer/sealer.
    - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
    - 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
  - d. Institutional Low-Odor/VOC Latex System: MPI INT 6.2L.
    - 1) Prime Coat: Interior latex-based wood primer.
    - 2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
    - 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
  - e. High-Performance Architectural Latex System: MPI INT 6.2B.
    - 1) Prime Coat: Interior alkyd primer/sealer.
    - 2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
    - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.



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



- 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
- e. High-Performance Architectural Latex System: MPI INT 9.2B.
  - 1) Prime Coat: Interior latex primer/sealer.
  - 2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
  - 3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
15. Spray-Textured Ceiling Substrates:
  - a. Latex (Flat) System: MPI INT 9.1A, spray applied.
    - 1) Prime Coat: Interior latex primer/sealer **OR** (flat), **as directed**.
    - 2) Topcoat: Interior latex (flat).
  - b. Latex System: MPI INT 9.1E, spray applied.
    - 1) Prime Coat: Interior latex matching topcoat.
    - 2) Intermediate Coat: Interior latex matching topcoat.
    - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
  - c. Latex Over Alkyd Primer System: MPI INT 9.1B.
    - 1) Prime Coat: Interior alkyd primer/sealer.
    - 2) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
  - d. Alkyd (Flat) System: MPI INT 9.1C.
    - 1) Prime Coat: Interior alkyd (flat).
    - 2) Topcoat: Interior alkyd (flat).
  - e. Alkyd System: MPI INT 9.1D.
    - 1) Prime Coat: Interior alkyd primer/sealer.
    - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
    - 3) Topcoat: Interior alkyd (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
16. Cotton or Canvas Insulation-Covering Substrates: Including pipe and duct coverings.
  - a. Latex System: MPI INT 10.1A.
    - 1) Prime Coat: Interior latex primer/sealer (for MPI Premium Grade system) **OR** matching topcoat, **as directed**.
    - 2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
    - 3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
  - b. Alkyd Over Latex Primer System: MPI INT 10.1B.
    - 1) Prime Coat: Interior latex primer/sealer.
    - 2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
    - 3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
  - c. Aluminum Paint System: MPI INT 10.1C.
    - 1) Prime Coat: Interior latex primer/sealer.
    - 2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.
    - 3) Topcoat: Aluminum paint.
  - d. Institutional Low-Odor/VOC Latex System: MPI INT 10.1D.
    - 1) Prime Coat: Interior latex primer/sealer.
    - 2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
    - 3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

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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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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
09 91 23 00	09 91 13 00	Exterior Painting
09 91 33 00	09 91 13 00a	Wood Stains and Transparent Finishes
09 91 33 00	09 91 13 00b	High-Temperature-Resistant Coatings



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## SECTION 09 91 43 00 - CONCRETE REHABILITATION

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. This Section includes the following:
  - a. Removal of deteriorated concrete and reinforcement and subsequent replacement and patching.
  - b. Floor joint repair.
  - c. Epoxy crack injection.
  - d. Corrosion-inhibiting treatment.
  - e. Polymer overlays.
  - f. Polymer sealers.
  - g. Steel structural reinforcement.
  - h. Composite structural reinforcement.

#### C. Submittals

1. Product Data: For each type of product indicated. Include material descriptions, chemical composition, physical properties, test data, and mixing, preparation, and application instructions.
2. Formwork and Shoring Drawings: Prepared by or under the supervision of a qualified professional engineer detailing formwork and temporary shoring and supports. Include schedule and sequence for erection and removal relative to removal of deteriorated concrete and reinforcement and subsequent repair and reinforcement.
3. Samples: Cured Samples of overlay and patching materials.
4. Rehabilitation Program: For each phase of rehabilitation process, including protection of surrounding materials and Project site during operations. Describe in detail materials, methods, equipment, and sequence of operations to be used for each phase of the Work.
  - a. If alternative materials and methods to those indicated are proposed for any phase of rehabilitation work, submit substitution request and provide a written description of proposed materials and methods, including evidence of successful use on other comparable projects, and a testing program to demonstrate their effectiveness for this Project.

#### D. Delivery, Storage, And Handling

1. Deliver materials to Project site in manufacturer's original and unopened containers, labeled with type and name of products and manufacturers.
2. Comply with manufacturer's written instructions for minimum and maximum temperature requirements and other conditions for storage.
3. Store cementitious materials off the ground, under cover, and in a dry location.
4. Store aggregates, covered and in a dry location, where grading and other required characteristics can be maintained and contamination avoided.

#### E. Project Conditions

1. Environmental Limitations for Epoxies: Do not apply when air and substrate temperatures are outside limits permitted by manufacturer. During hot weather, cool epoxy components before mixing, store mixed products in shade, and cool unused mixed products to retard setting. Do not apply to wet substrates unless approved by manufacturer.



- a. Use only Class A epoxies when substrate temperatures are below or are expected to go below 40 deg F (5 deg C) within 8 hours.
  - b. Use only Class A or B epoxies when substrate temperatures are below or are expected to go below 60 deg F (16 deg C) within 8 hours.
  - c. Use only Class C epoxies when substrate temperatures are above and are expected to stay above 60 deg F (16 deg C) for 8 hours.
2. Cold-Weather Requirements for Cementitious Materials:
- a. Do not apply unless air temperature is above 40 deg F (5 deg C) and will remain so for at least 48 hours after completion of Work.  
**OR**  
Comply with the following procedures:
    - 1) When air temperature is below 40 deg F (5 deg C), heat patching material ingredients and existing concrete to produce temperatures between 40 and 90 deg F (5 and 32 deg C).
    - 2) When mean daily air temperature is between 25 and 40 deg F (minus 4 and plus 5 deg C), cover completed Work with weather-resistant insulating blankets for 48 hours after repair or provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for 48 hours after repair.
    - 3) When mean daily air temperature is below 25 deg F (minus 4 deg C), provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for 48 hours after repair.
3. Hot-Weather Requirements for Cementitious Materials: Protect repair work when temperature and humidity conditions produce excessive evaporation of water from patching materials. Provide artificial shade and wind breaks, and use cooled materials as required. Do not apply to substrates with temperatures of 90 deg F (32 deg C) and above.
4. Environmental Limitations for High-Molecular-Weight Methacrylate Sealers: Do not apply when concrete surface temperature is below 55 deg F (13 deg C) or above 75 deg F (24 deg C) **OR** 90 deg F (32 deg C), **as directed**. Apply only to dry substrates **OR** substrates that have been dry for at least 72 hours.

## 1.2 PRODUCTS

### A. Bonding Agents

1. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Product that consists of water-insensitive epoxy adhesive, portland cement, and water-based solution of corrosion-inhibiting chemicals that forms a protective film on steel reinforcement.
2. Epoxy Bonding Agent: ASTM C 881/C 881M, Type II **OR** V, **as directed**.  
a. Thin Film Open Time: Not less than two **OR** six **OR** 24, **as directed**, hours.
3. Latex Bonding Agent: ASTM C 1059, Type I **OR** II **OR** II at exterior locations and where indicated, Type I at other locations, **as directed**.
4. Mortar Scrub-Coat: 1 part portland cement complying with ASTM C 150, Type I, II, or III and 1 part fine aggregate complying with ASTM C 144, except 100 percent passing a No. 16 (1.18-mm) sieve.

### B. Patching Mortar

1. Patching Mortar, General:
  - a. Overhead Patching Mortar: For overhead repairs, use patching mortar recommended by manufacturer for overhead use and as specified in this Article.
  - b. Coarse Aggregate for Adding to Patching Mortar: Washed aggregate complying with ASTM C 33, Size No. 8, Class 5S. Add only as permitted by patching mortar manufacturer.
2. Job-Mixed Patching Mortar: 1 part portland cement complying with ASTM C 150, Type I, II, or III and 2-1/2 parts fine aggregate complying with ASTM C 144, except 100 percent passing a No. 16 (1.18-mm) sieve.



3. Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928.
4. Polymer-Modified, Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928, that contains a non-redispersible latex additive as either a dry powder or a separate liquid that is added during mixing.
5. Polymer-Modified, Silica-Fume-Enhanced, Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928, that contains silica fume complying with ASTM C 1240 and a non-redispersible latex additive as either a dry powder or a separate liquid that is added during mixing.

#### C. Concrete

1. Concrete Materials and Admixtures: Comply with Division 03 Section "Cast-in-place Concrete".
2. Steel and Fiber Reinforcement and Reinforcement Accessories: Comply with Division 03 Section "Cast-in-place Concrete".
3. Form-Facing Materials: Comply with Division 03 Section "Cast-in-place Concrete".
4. Shotcrete: Comply with Division 03 Section "Shotcrete".
5. Preplaced Aggregate: Washed aggregate complying with ASTM C 33, Class 5S, with 95 to 100 percent passing a 1-1/2-inch (37.5-mm) sieve, 40 to 80 percent passing a 1-inch (25-mm) sieve, 20 to 45 percent passing a 3/4-inch (19-mm) sieve, 0 to 10 percent passing a 1/2-inch (12.5-mm) sieve, and 0 to 2 percent passing a 3/8-inch (9.5-mm) sieve **OR** 100 percent passing a 1-1/2-inch (37.5-mm) sieve, 95 to 100 percent passing a 1-inch (25-mm) sieve, 40 to 80 percent passing a 3/4-inch (19-mm) sieve, 0 to 15 percent passing a 1/2-inch (12.5-mm) sieve, and 0 to 2 percent passing a 3/8-inch (9.5-mm) sieve, **as directed**.
6. Fine Aggregate for Grout Used with Preplaced Aggregate: Fine aggregate complying with ASTM C 33, but with 100 percent passing a No. 8 (2.36-mm) sieve, 95 to 100 percent passing a No. 16 (1.18-mm) sieve, 55 to 80 percent passing a No. 30 (0.6-mm) sieve, 30 to 55 percent passing a No. 50 (0.3-mm) sieve, 10 to 30 percent passing a No. 100 (0.15-mm) sieve, 0 to 10 percent passing a No. 200 (0.075-mm) sieve, and having a fineness modulus of 1.30 to 2.10.
7. Grout Fluidifier for Grout Used with Preplaced Aggregate: ASTM C 937.
8. Portland Cement for Grout Used with Preplaced Aggregate: ASTM C 150.
9. Pozzolans for Grout Used with Preplaced Aggregate: ASTM C 618.

#### D. Miscellaneous Materials

1. Epoxy Joint Filler: 2-component, semirigid, 100 percent solids, epoxy resin with a Type A Shore durometer hardness of at least 80 per ASTM D 2240.
2. Polyurea Joint Filler: 2-component, semirigid, 100 percent solids, polyurea resin with a Type A Shore durometer hardness of at least 80 per ASTM D 2240.
3. Epoxy Crack Injection Adhesive: ASTM C 881/C 881M, Type I **OR** IV, **as directed**, Grade 1, except for gel time **OR** solvent free, **as directed**.
4. Capping Adhesive: Product manufactured for use with crack injection adhesive by same manufacturer.
5. Corrosion-Inhibiting Treatment Materials: Water-based solution of alkaline corrosion-inhibiting chemicals that penetrates concrete by diffusion and forms a protective film on steel reinforcement.
6. Polymer Overlay: Epoxy adhesive complying with ASTM C 881/C 881M, Type III.
7. Aggregate for Use with Polymer Overlay: Oven-dried, washed silica sand complying with ACI 503.3.
8. Polymer Sealer: Low-viscosity epoxy or high-molecular-weight methacrylate penetrating sealer recommended by manufacturer for application to exterior concrete traffic surfaces.
9. Methylmethacrylate Sealer/Brighteners: Clear low-viscosity sealer recommended by manufacturer for sealing exterior exposed-aggregate concrete, and formulated to bring out color of aggregates and give concrete a wet look.
10. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
  - a. After fabricating, prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."



- b. For minimum protection to steel after preparation, apply one coat of lead- and chromate-free, modified-alkyd primer complying with MPI#76 and one coat of alkyd-gloss enamel complying with MPI#96.
- c. After preparation, apply two-coat high-performance coating system consisting of organic zinc-rich primer, complying with SSPC-Paint 20 or SSPC-Paint 29 and topcoat of high-build, urethane or epoxy coating recommended by manufacturer for application over specified zinc-rich primer. Comply with coating manufacturer's written directions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
11. Bolts, Nuts, and Washers: Carbon steel; ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), for bolts; ASTM A 563 (ASTM A 563M), Grade A, for nuts; and ASTM F 436 (ASTM F 436M) for washers; hot-dip or mechanically zinc coated.
12. Postinstalled Anchors: Chemical or expansion anchors, made from stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group A1 or A4) for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors, with capability to sustain, without failure, a load equal to four times the load imposed, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
13. Composite Structural Reinforcement: Manufacturer's system consisting of carbon **OR** glass, **as directed**,-fiber reinforcement in the form of preimpregnated sheets or tow sheet with field-applied saturant, and epoxy primers, fillers, adhesives, saturants, and topcoats, designed for use as external structural reinforcement for concrete.

#### E. Mixes

1. Mix products, in clean containers, according to manufacturer's written instructions.
  - a. Add clean silica sand and coarse aggregates to products only as recommended by manufacturer.
  - b. Do not add water, thinners, or additives unless recommended by manufacturer.
  - c. When practical, use manufacturer's premeasured packages to ensure that materials are mixed in proper proportions. When premeasured packages are not used, measure ingredients using graduated measuring containers; do not estimate quantities or use shovel or trowel as unit of measure.
  - d. Do not mix more materials than can be used within recommended open time. Discard materials that have begun to set.
2. Mortar Scrub-Coat: Mix with enough water to provide consistency of thick cream.
3. Dry-Pack Mortar: Mix with just enough liquid to form damp cohesive mixture that can be squeezed by hand into a ball but is not plastic.
4. Concrete: Comply with Division 03 Section "Cast-in-place Concrete".
5. Shotcrete: Comply with Division 03 Section "Shotcrete".
6. Grout for Use with Preplaced Aggregate: Proportion according to ASTM C 938. Add grout fluidifier to mixing water followed by cementitious materials and then fine aggregate.

### 1.3 EXECUTION

#### A. Examination

1. Notify the Owner seven days in advance of dates when areas of deteriorated or delaminated concrete and deteriorated reinforcing bars will be located.
2. Locate areas of deteriorated or delaminated concrete using hammer or chain drag sounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries. At columns and walls make boundaries level and plumb, unless otherwise indicated.
3. Locate at least three reinforcing bars using a pachometer, and drill test holes to determine depth of cover. Calibrate pachometer, using depth of cover measurements, and verify depth of cover in removal areas using pachometer.

**B. Preparation**

1. Protect people, motor vehicles, equipment, surrounding construction, Project site, plants, and surrounding buildings from injury resulting from concrete rehabilitation work.
  - a. Erect and maintain temporary protective covers over pedestrian walkways and at points of entrance and exit for people and vehicles, unless such areas are made inaccessible during the course of concrete rehabilitation work. Construct covers of tightly fitted, 3/4-inch (19-mm) exterior-grade plywood supported at 16 inches (405 mm) o.c. and covered with asphalt roll roofing.
  - b. Protect adjacent equipment and surfaces by covering them with heavy polyethylene film and waterproof masking tape or a liquid strippable masking agent. If practical, remove items, store, and reinstall after potentially damaging operations are complete.
  - c. Neutralize and collect alkaline and acid wastes according to requirements of authorities having jurisdiction, and dispose of by legal means off the Owner's property.
  - d. Dispose of runoff from wet operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.
  - e. Collect runoff from wet operations and dispose of by legal means off the Owner's property.
2. Shoring: Install temporary supports before beginning concrete removal.
3. Concrete Removal:
  - a. Saw-cut perimeter of areas indicated for removal to a depth of at least 1/2 inch (13 mm). Make cuts perpendicular to concrete surfaces and no deeper than cover on reinforcement.
  - b. Remove deteriorated and delaminated concrete by breaking up and dislodging from reinforcement.
  - c. Remove additional concrete, if necessary, to provide a depth of removal of at least 1/2 inch (13 mm) over entire removal area.
  - d. Where half or more of the perimeter of reinforcing bar is exposed, bond between reinforcing bar and surrounding concrete is broken, or reinforcing bar is corroded, remove concrete from entire perimeter of bar and to provide at least a 3/4-inch (19-mm) clearance around bar.
  - e. Test areas where concrete has been removed by tapping with hammer, and remove additional concrete until unsound and disbonded concrete is completely removed.
  - f. Provide fractured aggregate surfaces with a profile of at least 1/8 inch (3 mm) that are approximately perpendicular or parallel to original concrete surfaces. At columns and walls, make top and bottom surfaces level, unless otherwise directed.
  - g. Thoroughly clean removal areas of loose concrete, dust, and debris.
4. Reinforcing Bar Preparation: Remove loose and flaking rust from reinforcing bars by high-pressure water cleaning **OR** abrasive blast cleaning **OR** needle scaling **OR** wire brushing, **as directed**, until only tightly bonded light rust remains.
  - a. Where section loss of reinforcing bar is more than 25 percent, or 20 percent in 2 or more adjacent bars, cut bars and remove and replace. Remove additional concrete as necessary to provide at least 3/4-inch (19-mm) clearance at existing and replacement bars. Splice replacement bars to existing bars according to ACI 318 (ACI 318M), by lapping, welding, or using mechanical couplings.
5. Preparation of Floor Joints for Repair: Saw-cut joints full width to edges and depth of spalls, but not less than 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**, deep. Clean out debris and loose concrete; vacuum or blow clear with compressed air.
6. Surface Preparation for Corrosion-Inhibiting Treatment: Clean concrete by low-pressure water cleaning **OR** detergent scrubbing **OR** sand blasting, **as directed**, to remove dirt, oils, films, and other materials detrimental to treatment application. Allow surface to dry before applying corrosion-inhibiting treatment.
7. Surface Preparation for Overlays: Remove delaminated material and deteriorated concrete surface material. Roughen surface of concrete by sand blasting **OR** shot blasting **OR** scarifying **OR** needle scaling **OR** high-pressure water jetting **OR** scabbling **OR** flame blasting **OR** milling, **as directed**, to produce a surface profile matching CSP 3 **OR** 4 **OR** 5 **OR** 6 **OR** 7 **OR** 8 **OR** 9, **as directed**, per ICRI 03732. Sweep and vacuum roughened surface to remove debris followed by low-pressure water cleaning.



8. Surface Preparation for Sealers: Clean concrete by shot blasting **OR** low-pressure water cleaning **OR** detergent scrubbing, **as directed**, to remove dirt, oils, films, and other materials detrimental to sealer application.
9. Surface Preparation for Sealers: Acid etch surface of concrete to produce a surface profile matching CSP 1 per ICRI 03732. Prepare surface for acid etching by detergent scrubbing to remove oils and films that may prevent acid penetration.
  - a. Remove excess acid solution, reaction products, and debris by squeegeeing or vacuuming.
  - b. Scrub surface with an alkaline detergent, rinse, and squeegee or vacuum.
  - c. Check acidity of surface with pH test paper and continue rinsing until pH is acceptable.
  - d. When pH is acceptable and surface is clean, vacuum dry.
10. Surface Preparation for Composite Structural Reinforcement: Remove delaminated material and deteriorated concrete surface material. Clean concrete where reinforcement and epoxy patching mortar is to be applied by low-pressure water cleaning **OR** detergent scrubbing, **as directed**, to remove dirt, oils, films, and other materials detrimental to epoxy application. Roughen surface of concrete by sand blasting.

#### C. Application

1. General: Comply with manufacturer's written instructions and recommendations for application of products, including surface preparation.
2. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Apply to reinforcing bars and concrete by stiff brush or hopper spray according to manufacturer's written instructions. Apply to reinforcing bars in two coats, allowing first coat to dry two to three hours before applying second coat. Allow to dry before placing patching mortar or concrete.
3. Epoxy Bonding Agent: Apply to reinforcing bars and concrete by brush, roller, or spray according to manufacturer's written instructions, leaving no pinholes or other uncoated areas. Apply to reinforcing bars in at least two coats, allowing first coat to dry before applying second coat. Apply patching mortar or concrete while epoxy is still tacky. If epoxy dries, recoat before placing patching mortar or concrete.
4. Latex Bonding Agent, Type II: Mix with portland cement and scrub into concrete surface according to manufacturer's written instructions. Apply patching mortar or concrete while bonding agent is still wet. If bonding agent dries, recoat before placing patching mortar or concrete.
5. Latex Bonding Agent, Type I: Apply to concrete by brush roller or spray. Allow to dry before placing patching mortar or concrete.
6. Mortar Scrub-Coat: Dampen repair area and surrounding concrete 6 inches (150 mm) beyond repair area. Remove standing water and apply scrub-coat with a brush, scrubbing it into surface and thoroughly coating repair area. If scrub-coat dries, recoat before applying patching mortar or concrete.
7. Patching Mortar: Unless otherwise recommended by manufacturer, apply as follows:
  - a. Wet substrate thoroughly and then remove standing water. Scrub a slurry of neat patching mortar mixed with latex bonding agent into substrate, filling pores and voids.
  - b. Place patching mortar by troweling toward edges of patch to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch. At fully exposed reinforcing bars, force patching mortar to fill space behind bars by compacting with trowel from sides of bars.
  - c. For vertical patching, place material in lifts of not more than 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, nor less than 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**. Do not feather edge.
  - d. For overhead patching, place material in lifts of not more than 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, nor less than 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**. Do not feather edge.
  - e. After each lift is placed, consolidate material and screed surface.
  - f. Where multiple lifts are used, score surface of lifts to provide a rough surface for application of subsequent lifts. Allow each lift to reach final set before placing subsequent lifts.



- g. Allow surfaces of lifts that are to remain exposed to become firm and then finish to a smooth **OR** rough, **as directed**, surface with a wood or sponge float **OR** broom or burlap drag, **as directed**.
- h. Wet-cure cementitious patching materials, including polymer-modified, cementitious patching materials, for not less than seven days by water-fog spray or water-saturated absorptive cover.
- 8. Dry-Pack Mortar: Use for deep cavities and where indicated. Unless otherwise recommended by manufacturer, apply as follows:
  - a. Provide forms where necessary to confine patch to required shape.
  - b. Wet substrate and forms thoroughly and then remove standing water.
  - c. Place dry-pack mortar into cavity by hand, and compact into place with a hardwood drive stick and mallet or hammer. Do not place more material at a time than can be properly compacted. Continue placing and compacting until patch is approximately level with surrounding surface.
  - d. After cavity is filled and patch is compacted, trowel surface to match profile and finish of surrounding concrete. A thin coat of patching mortar may be troweled into the surface of patch to help obtain required finish.
  - e. Wet-cure patch for not less than seven days by water-fog spray or water-saturated absorptive cover.
- 9. Concrete: Place according to Division 03 Section "Cast-in-place Concrete" and as follows:
  - a. Apply epoxy-modified, cementitious bonding and anticorrosion agent **OR** epoxy bonding agent, **as directed**, to reinforcement and concrete substrate.
  - b. Apply latex bonding agent **OR** Type I, latex bonding agent **OR** mortar scrub-coat, **as directed**, to concrete substrate.
  - c. Use vibrators to consolidate concrete as it is placed.
  - d. At unformed surfaces, screed concrete to produce a surface that when finished with patching mortar will match required profile and surrounding concrete.
  - e. Where indicated place concrete by form and pump method.
    - 1) Design and construct forms to resist pumping pressure in addition to weight of wet concrete. Seal joints and seams in forms and junctions of forms with existing concrete.
    - 2) Pump concrete into place, releasing air from forms as concrete is introduced. When formed space is full, close air vents and pressurize to 14 psi (96 kPa).
  - f. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.
  - g. Fill placement cavities with dry-pack mortar and repair voids with patching mortar. Finish to match surrounding concrete.
- 10. Shotcrete: Place according to Division 03 Section "Shotcrete" and as follows:
  - a. Apply epoxy-modified, cementitious bonding and anticorrosion agent **OR** epoxy bonding agent, **as directed**, to reinforcement and concrete substrate.
  - b. Apply latex bonding agent **OR** Type I, latex bonding agent **OR** mortar scrub-coat, **as directed**, to concrete substrate.
  - c. Screed and finish shotcrete to produce a surface matching required profile and surrounding concrete.
- 11. Grouted Preplaced Aggregate Concrete: Use for column and wall repairs **OR** where indicated, **as directed**. Place as follows:
  - a. Design and construct forms to resist pumping pressure in addition to weight of wet grout. Seal joints and seams in forms and junctions of forms with existing concrete.
  - b. Apply epoxy-modified, cementitious bonding and anticorrosion agent **OR** epoxy bonding agent, **as directed**, to reinforcement and concrete substrate.
  - c. Place aggregate in forms, consolidating aggregate as it is placed. Pack aggregate into upper areas of forms to achieve intimate contact with concrete surfaces.
  - d. Fill forms with water to thoroughly dampen aggregate and substrates. Drain water from forms before placing grout.



- e. Pump grout into place at bottom of preplaced aggregate, forcing grout upward. Release air from forms at top as grout is introduced. When formed space is full and grout flows from air vents, close vents and pressurize to 14 psi (96 kPa).
  - f. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.
  - g. Repair voids with patching mortar and finish to match surrounding concrete.
12. Joint Filler: Install in nonmoving floor joints where indicated.
- a. Install filler to a depth of at least 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**. Use fine silica sand no more than 1/4 inch (6 mm) deep to close base of joint. Do not use sealant backer rods or compressible fillers below joint filler.
  - b. Install filler so that when cured, it is flush at top surface of adjacent concrete. If necessary, overfill joint and remove excess when filler has cured.
13. Epoxy Crack Injection: Comply with manufacturer's written instructions and the following:
- a. Clean areas to receive capping adhesive of oil, dirt, and other substances that would interfere with bond, and clean cracks with oil-free compressed air or low-pressure water to remove loose particles.
  - b. Place injection ports as recommended by epoxy manufacturer, spacing no farther apart than thickness of member being injected. Seal injection ports in place with capping adhesive.
  - c. Seal cracks at exposed surfaces with a ribbon of capping adhesive at least 1/4 inch (6 mm) thick by 1 inch (25 mm) wider than crack.
  - d. Inject cracks wider than 0.003 inch (0.075 mm) to a depth of 8 inches (200 mm) or to a width of less than 0.003 inch (0.075 mm), whichever is less.
  - e. Inject epoxy adhesive, beginning at widest part of crack and working toward narrower parts. Inject adhesive into ports to refusal, capping adjacent ports when they extrude epoxy. Cap injected ports and inject through adjacent ports until crack is filled.
  - f. After epoxy adhesive has set, remove injection ports and grind surfaces smooth.
14. Corrosion-Inhibiting Treatment: Apply by brush, roller, or airless spray in two coats at manufacturer's recommended application rate. Remove film of excess treatment by high-pressure washing before patching treated concrete or applying a sealer or overlay.
15. Polymer Overlay: Apply according to ACI 503.3.
- a. Apply to traffic-bearing surfaces, including parking areas and walks.
16. Polymer Sealer: Apply by brush, roller, or airless spray at manufacturer's recommended application rate.
- a. Apply to traffic-bearing surfaces, including parking areas and walks.
17. Methylmethacrylate Sealer/Brighteners: Apply by brush, roller, or airless spray at manufacturer's recommended application rate.
- a. Apply to exterior concrete surfaces that are exposed to view, excluding traffic-bearing surfaces.
18. Composite Structural Reinforcement Using Preimpregnated Fiber Sheet: Unless otherwise recommended by manufacturer, apply as follows:
- a. Patch surface defects with epoxy mortar and allow to set before beginning reinforcement application.
  - b. Apply epoxy adhesive to a thickness of 1/16 inch (1.6 mm) to prepared concrete surfaces in areas where composite structural reinforcement will be applied.
  - c. Clean preimpregnated fiber sheet with acetone or other suitable solvent, and apply epoxy adhesive to a thickness of 1/16 inch (1.6 mm).
  - d. Apply adhesive-coated fiber sheet to adhesive-coated concrete within open time of epoxy adhesive, and roll with a hard rubber roller until fiber sheet is fully embedded in adhesive, air pockets are removed, and adhesive is forced out from beneath fiber sheet at edges.
  - e. Apply additional layers as indicated using same procedure.
19. Composite Structural Reinforcement Using Fiber Tow Sheet and Saturant: Unless otherwise recommended by manufacturer, apply as follows:
- a. Apply epoxy primer using brush or short nap roller to prepared concrete surfaces in areas where composite structural reinforcement will be applied.



- b. After primer has set, patch surface defects with epoxy filler and allow to set before beginning reinforcement application.
  - c. Apply epoxy saturant to fiber tow sheet or primed and patched surface with 3/8-inch- (10-mm-) nap roller. Apply fiber tow sheet to primed and patched surface while saturant is still wet, using pressure roller to remove air pockets. Remove paper backing from fiber tow sheet and apply additional epoxy as needed to fully saturate tow sheet.
  - d. Apply additional layers as indicated, fully saturating each with epoxy.
  - e. After saturant has cured, apply protective topcoat by brush, roller or spray.
- D. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to sample materials and perform tests as follows:
    - a. Patching Mortar, Packaged Mixes: **<Insert number>** randomly selected samples tested according to ASTM C 928.
    - b. Patching Mortar, Field Mixed: **<Insert number>** randomly selected samples tested for compressive strength according to ASTM C 109/C 109M.
    - c. Concrete: As specified in Division 03 Section "Cast-in-place Concrete".
    - d. Shotcrete: As specified in Division 03 Section "Shotcrete".
    - e. Grouted Preplaced Aggregate: Tested for compressive strength of grout according to ASTM C 942.
      - 1) Testing Frequency: One sample for each 25 cu. yd. (19 cu. m) of grout or fraction thereof, but not less than one sample for each day's work.
    - f. Joint Filler: Core drilled samples to verify proper installation.
      - 1) Testing Frequency: One sample for each 100 feet (30 m) of joint filled.
      - 2) Where samples are taken, fill holes with joint filler.
    - g. Epoxy Crack Injection: Core drilled samples to verify proper installation.
      - 1) Testing Frequency: 3 samples from mockup and 1 sample for each 100 feet (30 m) of crack injected.
      - 2) Where samples are taken, fill holes with epoxy mortar.

END OF SECTION 09 91 43 00



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## SECTION 09 93 23 53 - FLOOR TREATMENT REFINISHING WOOD FLOORS

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Submittals

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

#### C. Quality Assurance

1. Build mockup of typical flooring area as shown on Drawings including base and shoe moldings.
  - a. To set quality standards for sanding and application of field finishes, prepare finish mockup of floor area as shown on Drawings.
  - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - c. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

### 1.2 PRODUCTS

- A. Cleaning Compound: A liquid chemical cleaner containing non-ionic and anionic type detergents, non-reactive to wood flooring. Compound shall have no free metal alkalies, no artificial coloring and no fatty acids. Compound shall be UL listed as "slip-resistant."
- B. Varnish Remover: Non-flammable paint and varnish remover.
- C. Stain: Penetrating type non-fading wood stain.
- D. Wood Filler: Paste type wood filler, pigmented if necessary to match sample, complying with Fed. Spec. TT-F-336.
- E. Floor Sealer: Penetrating type, pliable, wood-hardening finish/sealer.
- F. Floor Varnish: Alkyd resin varnish, specially compounded for floor finish, Fed. Spec. TT-V-109.
- G. Urethane Finish: Specially compounded for wood floor finish, moisture curing type, for multiple-coat application.
- H. Floor Wax: Liquid, solvent-type, slip-resistant, CID A-A-1550, Type II.

### 1.3 EXECUTION

#### A. Preparation:

1. Cleaning: Scrub thoroughly with cleaning compound and warm water. Rinse with clean water, mop dry, and buff with polishing machine.
2. Varnish Removal: Apply paint and varnish remover as required.



3. Sanding: Traverse floors two times with an electric-powered sanding machine. A rotary disc sander may be used for the final cut, but first cut shall be made with a drum-type machine. The first cut may be made crosswise of the grain or at a 45-degree angle. Make second cut in direction of grain. Use No. 1/2 sandpaper for first traverse and No. 0 for second traverse. Use an electric edger or hand sander for sanding areas near walls, in corners, and small closets.

B. Installation:

1. Apply Wood Paste Filler, followed by wiping cross-grain to work into pores and cracks.
2. Apply Stain if needed to match selected finish.
3. Apply Sealer (2 coats) complying with Fed. Spec. TT-S-176. Use Class I for white oak and red oak floors and Class II for beech, birch, and hard maple floors.
4. Apply Floor Varnish, (3 coats) buffing after each coat. First coat may be thinned as a sealer.
5. Apply Urethane Finish. Apply as many coats as needed to build a dry film thickness of 1.0 mil.
6. When Floors are Dry, apply two coats of wax complying with Fed. Spec. P-W-155; concentration 12 percent. Spread the wax at the rate of 1,500 square feet per gallon and polish the floors with a weighted floor brush or an electric polisher.
7. Protection: Upon completion of work, cover all traffic areas immediately with nonstaining kraft paper or polyethylene, taped along edges, and maintain floor protection until acceptance.

END OF SECTION 09 93 23 53



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
09 93 23 53	09 91 13 00a	Wood Stains and Transparent Finishes

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## SECTION 09 96 00 00 - HIGH-PERFORMANCE COATINGS

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. This Section includes surface preparation and application of high-performance coating systems on the following substrates:
  - a. Exterior Substrates:
    - 1) Concrete, vertical and horizontal surfaces.
    - 2) Clay masonry.
    - 3) Concrete masonry units (CMU).
    - 4) Steel.
    - 5) Galvanized metal.
    - 6) Aluminum (not anodized or otherwise coated).
    - 7) Wood.
  - b. Interior Substrates:
    - 1) Concrete, vertical and horizontal surfaces.
    - 2) Clay masonry.
    - 3) Concrete masonry units (CMU).
    - 4) Steel.
    - 5) Galvanized metal.
    - 6) Aluminum (not anodized or otherwise coated).
    - 7) Wood.
    - 8) Gypsum board.

#### C. Submittals

1. Product Data: For each type of product indicated.
2. Samples: For each type of finish-coat product indicated.
3. Product List: For each product indicated. Cross-reference products to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules.
4. LEED Submittals:
  - a. Product Data for Credit EQ 4.2: For coatings, including printed statement of VOC content and chemical components.

#### D. Quality Assurance

1. Master Painters Institute (MPI) Standards:
  - a. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
  - b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" **OR** "MPI Maintenance Repainting Manual," **as directed**, for products and coating systems indicated.
2. Mockups: Apply mockups of each coating system indicated 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 coating system specified in Part 3.
    - 1) Wall and Ceiling 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 coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- 2. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

## 1.2 PRODUCTS

A. High-Performance Coatings, General

- 1. Material Compatibility:
  - a. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  - b. Provide products of same manufacturer for each coat in a coating system.
- 2. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
  - a. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
  - b. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
  - c. Anticorrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC content of not more than 250 g/L.
  - d. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
  - e. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
  - f. Floor Coatings: VOC not more than 100 g/L.
  - g. Shellacs, Clear: VOC not more than 730 g/L.
  - h. Shellacs, Pigmented: VOC not more than 550 g/L.
  - i. Stains: VOC content of not more than 250 g/L.
  - j. Flat Interior Topcoat Paints: VOC content of not more than 50 g/L.
  - k. Nonflat Interior Topcoat Paints: VOC content of not more than 150 g/L.
  - l. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
  - m. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
  - n. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
  - o. Floor Coatings: VOC not more than 100 g/L.
  - p. Shellacs, Clear: VOC not more than 730 g/L.
  - q. Shellacs, Pigmented: VOC not more than 550 g/L.
  - r. Stains: VOC not more than 250 g/L.
  - s. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
  - t. Zinc-Rich Industrial Maintenance Primers: VOC content of not more than 340 g/L.



- u. Pre-Treatment Wash Primers: VOC content of not more than 420 g/L.
  - 3. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
    - a. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing 1 or more benzene rings).
    - b. Restricted Components: Paints and coatings shall not contain any of the following:
      - 1) Acrolein.
      - 2) Acrylonitrile.
      - 3) Antimony.
      - 4) Benzene.
      - 5) Butyl benzyl phthalate.
      - 6) Cadmium.
      - 7) Di (2-ethylhexyl) phthalate.
      - 8) Di-n-butyl phthalate.
      - 9) Di-n-octyl phthalate.
      - 10) 1,2-dichlorobenzene.
      - 11) Diethyl phthalate.
      - 12) Dimethyl phthalate.
      - 13) Ethylbenzene.
      - 14) Formaldehyde.
      - 15) Hexavalent chromium.
      - 16) Isophorone.
      - 17) Lead.
      - 18) Mercury.
      - 19) Methyl ethyl ketone.
      - 20) Methyl isobutyl ketone.
      - 21) Methylene chloride.
      - 22) Naphthalene.
      - 23) Toluene (methylbenzene).
      - 24) 1,1,1-trichloroethane.
      - 25) Vinyl chloride.
  - 4. Colors: As selected from manufacturer's full range **OR** Match samples **OR** As indicated in color schedule, **as directed**.
- B. Block Fillers
- 1. Interior/Exterior Latex Block Filler: MPI#4.
    - a. VOC Content: Minimum E Range of E2 **OR** E3, **as directed**.
  - 2. Epoxy Block Filler: MPI #116.
    - a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
- C. Interior Primers/Sealers
- 1. Interior Latex Primer/Sealer: MPI #50.
    - a. Environmental Characteristics:
      - 1) VOC Content:
        - a) Minimum E Range of E2 **OR** E3, **as directed**.
        - b) Meets or exceeds LEED requirements for VOC content.
      - 2) Environmental Performance Rating (EPR): Minimum EPR 2 **OR** 3, **as directed**.
  - 2. Interior Alkyd Primer/Sealer: MPI #45.
    - a. VOC Content: Minimum E Range of E1 **OR** E2, **as directed**.
  - 3. Interior Latex-Based Wood Primer: MPI #39.
    - a. Environmental Characteristics:
      - 1) VOC Content:
        - a) Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.



- b) Meets or exceeds LEED requirements for VOC content.
    - 2) Environmental Performance Rating (EPR): Minimum EPR 1 **OR 2 OR 3, as directed.**
  - 4. Wood-Knot Sealer: White shellac or other sealer recommended in writing by manufacturer for this purpose.
- D. Metal Primers
  - 1. Inorganic Zinc Primer: MPI #19.
    - a. VOC Content: Minimum E Range of 0 **OR E1 OR E2 OR E3, as directed.**
  - 2. Epoxy Zinc Primer: MPI #20.
    - a. VOC Content: Minimum E Range of E1 **OR E2 OR E3, as directed.**
  - 3. Rust-Inhibitive Primer (Water Based): MPI #107.
    - a. Environmental Characteristics:
      - 1) VOC Content:
        - a) Minimum E Range of E1 **OR E2 OR E3, as directed.**
        - b) Meets or exceeds LEED requirements for VOC content.
      - 2) Environmental Performance Rating (EPR): Minimum EPR 1 **OR 2 OR 3, as directed.**
  - 4. Cold-Curing Epoxy Primer: MPI #101.
    - a. VOC Content: Minimum E Range of E1 **OR E3, as directed.**
  - 5. Alkyd Anticorrosive Metal Primer: MPI #79.
    - a. VOC Content: Minimum E Range of E1 **OR E2, as directed.**
  - 6. Quick-Dry Alkyd Metal Primer: MPI #76.
    - a. VOC Content: Minimum E Range of E1 **OR E2 OR E3, as directed.**
  - 7. Cementitious Galvanized-Metal Primer: MPI #26.
    - a. VOC Content: Minimum E Range of E1 **OR E2 OR E3, as directed.**
  - 8. Waterborne Galvanized-Metal Primer: MPI #134.
    - a. Environmental Characteristics:
      - 1) VOC Content:
        - a) Minimum E Range of E1 **OR E2 OR E3, as directed.**
        - b) Meets or exceeds LEED requirements for VOC content.
      - 2) Environmental Performance Rating (EPR): Minimum EPR 1 **OR 2 OR 3, as directed.**
  - 9. Quick-Drying Primer for Aluminum: MPI #95.
    - a. VOC Content: Minimum E Range of E1 **OR E2 OR E3, as directed.**
  - 10. Vinyl Wash Primer: MPI #80.
    - a. VOC Content: Minimum E Range of E2 **OR E3, as directed.**
- E. Water-Based, Light-Industrial Coatings
  - 1. Gloss, Water-Based, Light-Industrial Coating: MPI #110-G6.
    - a. Environmental Characteristics:
      - 1) VOC Content: Minimum E Range of E2.
      - 2) Environmental Performance Rating (EPR): Minimum EPR 2.
  - 2. Semigloss, Water-Based, Light-Industrial Coating: MPI #110-G5.
    - a. Environmental Characteristics:
      - 1) VOC Content:
        - a) Minimum E Range of E2 **OR E3, as directed.**
        - b) Meets or exceeds LEED requirements for VOC content.
      - 2) Environmental Performance Rating (EPR): Minimum EPR 2 **OR 3, as directed.**
  - 3. Eggshell, Water-Based, Light-Industrial Coating: MPI #110-G3.
    - a. Environmental Characteristics:
      - 1) VOC Content:
        - a) Minimum E Range of E2 **OR E3, as directed.**
        - b) Meets or exceeds LEED requirements for VOC content.
      - 2) Environmental Performance Rating (EPR): Minimum EPR 2 **OR 3, as directed.**



## F. Epoxy Coatings

1. Epoxy, Cold-Cured, Gloss: MPI #77.
  - a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Water-Based Epoxy (Interior and Exterior): MPI #115.
  - a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. High-Build Epoxy Marine Coating, Low Gloss: MPI #108.
  - a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
4. Epoxy Deck Coating: MPI #82.
  - a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
5. Water-Based Epoxy Floor Paint: MPI #93.
  - a. Environmental Characteristics:
    - 1) VOC Content:
      - a) Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
      - b) Meets or exceeds LEED requirements for VOC content.
    - 2) Environmental Performance Rating (EPR): Minimum EPR 1 **OR** 2 **OR** 3, **as directed**.

## G. Polyurethane Coatings

1. Polyurethane, Two-Component, Pigmented, Gloss: MPI #72.
  - a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Two-Component, Aliphatic Polyurethane, Clear: MPI #78.
  - a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Polyurethane, Moisture Cured, Clear, Gloss: MPI #31.
  - a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
4. Polyurethane, Moisture Cured, Clear, Flat: MPI #71.
  - a. VOC Content: Minimum E Range of E2.

## H. Interior High-Performance Architectural Latex Coatings

1. High-Performance Architectural Latex, Velvet Finish: MPI #138, Gloss Level 2.
  - a. Environmental Characteristics:
    - 1) VOC Content:
      - a) Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
      - b) Meets or exceeds LEED requirements for VOC content.
    - 2) Environmental Performance Rating (EPR): Minimum EPR 4 **OR** 5 **OR** 6, **as directed**.
2. High-Performance Architectural Latex, Eggshell Finish: MPI #139, Gloss Level 3.
  - a. Environmental Characteristics:
    - 1) VOC Content:
      - a) Minimum E Range of E2 **OR** E3, **as directed**.
      - b) Meets or exceeds LEED requirements for VOC content.
    - 2) Environmental Performance Rating (EPR): Minimum EPR 5 **OR** 6, **as directed**.
3. High-Performance Architectural Latex, Satin Finish: MPI #140, Gloss Level 4.
  - a. Environmental Characteristics:
    - 1) VOC Content:
      - a) Minimum E Range of E1 **OR** E3, **as directed**.
      - b) Meets or exceeds LEED requirements for VOC content.
    - 2) Environmental Performance Rating (EPR): Minimum EPR 4.5 **OR** 6.5, **as directed**.
4. High-Performance Architectural Latex, Semigloss Finish: MPI #141, Gloss Level 5.
  - a. Environmental Characteristics:
    - 1) VOC Content:
      - a) Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
      - b) Meets or exceeds LEED requirements for VOC content.
    - 2) Environmental Performance Rating (EPR): Minimum EPR 5 **OR** 6 **OR** 7, **as directed**.

## I. Wood Stains



1. Exterior Semitransparent Stain (Solvent Based): MPI #13.
  - a. VOC Content: Minimum E Range of E1 **OR** E2, **as directed**.
2. Interior Wood Stain, Semitransparent (Solvent Based): MPI #90.
  - a. VOC Content: Minimum E Range of E1 **OR** E2, **as directed**.

### 1.3 EXECUTION

#### A. Preparation

1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
2. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
  - a. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.
3. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants.
  - a. Remove incompatible primers and reprime substrate with compatible primers as required to produce coating systems indicated.
4. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
  - a. Clean surfaces with pressurized water. Use pressure range of 1500 to 4000 psi (10 350 to 27 580 kPa) at 6 to 12 inches (150 to 300 mm) **OR** 4000 to 10,000 psi (27 580 to 68 950 kPa), **as directed**.  
**OR**  
Abrasive blast clean surfaces to comply with SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."
5. Clay Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
  - a. Clean surfaces with pressurized water. Use pressure range of 100 to 600 psi (690 to 4140 kPa) **OR** 1500 to 4000 psi (10 350 to 27 580 kPa), **as directed**, at 6 to 12 inches (150 to 300 mm).
6. CMU Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
7. Steel Substrates (for field applied primers): Remove rust and loose mill scale.
  - a. Clean using methods recommended in writing by coating manufacturer.  
  
Blast clean according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning **OR** SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning **OR** SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning," **as directed**.
8. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.
9. Aluminum Substrates: Remove surface oxidation.
10. Wood Substrates:
  - a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of knot sealer before applying primer.
  - b. Sand surfaces that will be exposed to view and dust off.
  - c. Prime edges, ends, faces, undersides, and back sides of wood.
  - d. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

**B. Application**

1. Apply high-performance coatings according to manufacturer's written instructions.
  - a. Use applicators and techniques suited for coating and substrate indicated.
  - b. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
  - c. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
2. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
3. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
4. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

**C. Field Quality Control**

1. The following procedure may be requested at any time and as often as the Owner deems 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. Exterior High-Performance Coating Schedule**

1. Coating systems in this Article are based on "MPI Architectural Painting Specification Manual." For renovation projects, consult "MPI Maintenance Repainting Manual" and revise coating systems accordingly.
2. Concrete Substrates, Vertical Surfaces:
  - a. Water-Based, Light-Industrial Coating System (System below corresponds to MPI EXT 3.1C):
    - 1) Prime Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.
    - 2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
    - 3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
  - b. Epoxy Coating System (System below corresponds to MPI EXT 3.1D):
    - 1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.



- 2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
- 3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
- c. Water-Based Epoxy Coating System (System below corresponds to MPI EXT 3.1E):
  - 1) Prime Coat: Water-based epoxy (interior and exterior), MPI #115.
  - 2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
  - 3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.
3. Concrete Substrates, Horizontal Surfaces (System below corresponds to MPI EXT 3.2C):
  - a. Epoxy Slip-Resistant Deck Coating System:
    - 1) Topcoat: Epoxy deck coating, MPI #82.
4. Clay-Masonry Substrates (System below corresponds to MPI EXT 4.1C):
  - a. Water-Based, Light-Industrial Coating System:
    - 1) Prime Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.
    - 2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
    - 3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
  - b. Epoxy Coating System (System below corresponds to MPI EXT 4.1D) (MPI recommends this system for smooth brick.):
    - 1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
    - 2) Intermediate Coat : Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
    - 3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
  - c. Water-Based Epoxy Coating System (System below corresponds to MPI EXT 4.1E) (MPI recommends this system for smooth brick.):
    - 1) Prime Coat: Water-based epoxy (interior and exterior), MPI #115.
    - 2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
    - 3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.
  - d. Polyurethane, Pigmented, Over Epoxy Coating System (System below corresponds to MPI EXT 4.1J):
    - 1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
    - 2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
    - 3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
5. CMU Substrates:
  - a. Water-Based, Light-Industrial Coating System (System below corresponds to MPI EXT 4.2C):
    - 1) Prime Coat: Interior/exterior latex block filler, MPI #4.
    - 2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
    - 3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
  - b. Epoxy Coating System (System below corresponds to MPI EXT 4.2E):
    - 1) Block Filler: Epoxy block filler, MPI #116.
    - 2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
    - 3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
  - c. Water-Based Epoxy Coating System (System below corresponds to MPI EXT 4.2F):
    - 1) Block Filler: Epoxy block filler, MPI #116.
    - 2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
    - 3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.



- d. Polyurethane, Pigmented, Over High-Build Epoxy Coating System (System below corresponds to MPI EXT 4.2G):
  - 1) Block Filler: Epoxy block filler, MPI #116.
  - 2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
  - 3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
6. Steel Substrates:
  - a. Water-Based, Light-Industrial Coating System (System below corresponds to MPI EXT 5.1B, MPI EXT 5.1C, MPI EXT 5.1M and MPI EXT 5.1N, depending on primer selected):
    - 1) Prime Coat: Inorganic zinc primer, MPI #19 **OR** Alkyd anticorrosive metal primer, MPI #79 **OR** Rust-inhibitive primer, (water based), MPI #107 **OR** Cold-curing epoxy primer, MPI #101, **as directed**, primer.
    - 2) Intermediate Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat (intermediate coat is required for coating systems except MPI Custom Grade system using inorganic zinc primer).
    - 3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
  - b. High-Build Epoxy Coating System (System below corresponds to MPI EXT 5.1F):
    - 1) Prime Coat: Cold-curing epoxy primer, MPI #101.
    - 2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
    - 3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
  - c. Water-Based Epoxy Coating System (System below corresponds to MPI EXT 5.1E):
    - 1) Prime Coat: Rust-inhibitive primer, (water based), MPI #107.
    - 2) Intermediate Coat: Water-based epoxy (interior and exterior), MPI #115.
    - 3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.
  - d. Polyurethane, Pigmented, Over Epoxy Coating System (System below corresponds to MPI EXT 5.1H):
    - 1) Prime Coat: Cold-curing epoxy primer, MPI #101.
    - 2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
    - 3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
    - 4) Second Topcoat (for Premium Grade system): Polyurethane, two-component, pigmented, gloss, MPI #72.
  - e. Polyurethane, Pigmented, Over Epoxy Coating System (System below corresponds to MPI EXT 5.1P)
    - 1) Prime Coat: Epoxy zinc primer, MPI#20.
    - 2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
    - 3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
    - 4) Second Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
  - f. Polyurethane, Pigmented, Over High-Build Epoxy Coating System (System below corresponds to MPI EXT 5.1G):
    - 1) Prime Coat: Epoxy zinc primer, MPI#20.
    - 2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
    - 3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
    - 4) Second Topcoat (for Premium Grade system): Polyurethane, two-component, pigmented, gloss, MPI #72.
  - g. Polyurethane, Pigmented, Over High-Build Epoxy Coating System (System below corresponds to MPI EXT 5.1J):
    - 1) Prime Coat: Cold-curing epoxy primer, MPI #101.
    - 2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
    - 3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
    - 4) Second Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
  - h. Polyurethane, Pigmented, Over High-Build Epoxy Coating System (System below corresponds to MPI EXT 5.1L):
    - 1) Prime Coat: Inorganic zinc primer, MPI #19.
    - 2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
    - 3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.



- 4) Second Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
7. Galvanized-Metal Substrates:
  - a. Water-Based, Light-Industrial Coating System (System below corresponds to MPI EXT 5.3G and MPI EXT 5.3J, depending on primer selected):
    - 1) Prime Coat: Cementitious galvanized-metal primer, MPI #26 **OR** Waterborne galvanized-metal primer, MPI #134, **as directed**.
    - 2) Intermediate Coat (for Premium Grade system): Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
    - 3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
  - b. Epoxy Coating System (System below corresponds to MPI EXT 5.3C) (MPI recommends this system for high-contact and -traffic areas.):
    - 1) Prime Coat: Cold-curing epoxy primer, MPI #101.
    - 2) Intermediate Coat (for Premium Grade system): Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
    - 3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
  - c. Polyurethane, Pigmented Coating System (System below corresponds to MPI EXT 5.3D) (MPI recommends these systems for high-contact and -traffic areas.):
    - 1) Prime Coat: Vinyl wash primer, MPI #80.
    - 2) Intermediate Coat: Not required **OR** Cold-curing epoxy primer, MPI #101, **as directed**.
    - 3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
    - 4) Second Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
  - d. Polyurethane, Pigmented Coating System (System below corresponds to MPI EXT 5.3L):
    - 1) Prime Coat: Cold-curing epoxy primer, MPI #101.
    - 2) Intermediate Coat: Not required **OR** Polyurethane, two-component, pigmented, gloss, MPI #72, **as directed**.
    - 3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
    - 4) Second Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
8. Aluminum (Not Anodized or Otherwise Coated) Substrates:
  - a. Water-Based, Light-Industrial Coating System (System below corresponds to MPI EXT 5.4G):
    - 1) Prime Coat: Quick-drying primer for aluminum, MPI #95.
    - 2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
    - 3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
  - b. Epoxy Coating System (System below corresponds to MPI EXT 5.4E):
    - 1) Prime Coat: Vinyl wash primer, MPI #80.
    - 2) Intermediate Coat (for Premium Grade system): Epoxy, cold-cured, gloss, MPI #77.
    - 3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
  - c. Polyurethane, Pigmented Coating System (System below corresponds to MPI EXT 5.4B) (MPI recommends these systems for high-contact and -traffic areas.):
    - 1) Prime Coat: Vinyl wash primer, MPI #80.
    - 2) Intermediate Coat: Cold-curing epoxy primer, MPI #101.
    - 3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
    - 4) Second Topcoat (for Premium Grade system): Polyurethane, two-component, pigmented, gloss, MPI #72.
9. Wood Substrates:
  - a. Pigmented Polyurethane Coating System (System below corresponds to MPI EXT 6.1J, MPI EXT 6.2J, and MPI EXT 6.3H):
    - 1) Prime Coat: Polyurethane, two-component, pigmented, gloss, MPI #72.
    - 2) Intermediate Coat: Polyurethane, two-component, pigmented, gloss, MPI #72.
    - 3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.



- b. Polyurethane, Clear, Two-Component Coating System (System below corresponds to MPI EXT 6.1E for use on glue-laminated beams and columns):
    - 1) Stain Coat: Exterior semitransparent stain (solvent based), MPI #13.
    - 2) Intermediate Coat: Two-component, aliphatic polyurethane, clear, MPI #78.
    - 3) First Topcoat: Two-component, aliphatic polyurethane, clear, MPI #78.
    - 4) Second Topcoat (for Premium Grade systems): Two-component, aliphatic polyurethane, clear, MPI #78.
- F. Interior High-Performance Coating Schedule
- 1. Coating systems in this Article are based on "MPI Architectural Painting Specification Manual." For renovation projects, consult "MPI Maintenance Repainting Manual" and revise coating systems accordingly.
  - 2. Concrete Substrates, Vertical Surfaces (System below corresponds to MPI INT 3.1C):
    - a. High-Performance Architectural Latex Coating System:
      - 1) Prime Coat: Interior latex primer/sealer, MPI #50.
      - 2) Intermediate Coat: Not required **OR** High-performance architectural latex matching topcoat, **as directed**.
      - 3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.
    - b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 3.1L):
      - 1) Prime Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.
      - 2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
      - 3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
    - c. Epoxy Coating System (System below corresponds to MPI INT 3.1F.) (MPI recommends this system for smooth concrete.):
      - 1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
      - 2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
      - 3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
    - d. Water-Based Epoxy Coating System (System below corresponds to MPI INT 3.1G) (MPI recommends this system for smooth concrete.):
      - 1) Prime Coat: Water-based epoxy (interior and exterior), MPI #115.
      - 2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
      - 3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.
  - 3. Concrete Substrates, Horizontal Surfaces.
    - a. Epoxy Coating System (System below corresponds to MPI INT 3.2C):
      - 1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
      - 2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
      - 3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
    - b. Water-Based Epoxy Floor Paint Coating System (System below corresponds to MPI INT 3.2L).
      - 1) Prime Coat: Water-based epoxy floor paint, MPI #93.
      - 2) Intermediate Coat: Not required **OR** Water-based epoxy floor paint, MPI #93, **as directed**.
      - 3) Topcoat: Water-based epoxy floor paint, MPI #93.
    - c. Polyurethane, Pigmented Coating System (System below corresponds to MPI INT 3.2D):
      - 1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
      - 2) Intermediate Coat: Not required **OR** Polyurethane, two-component, pigmented, gloss, MPI #72, **as directed**.



- 3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
- d. Polyurethane, Clear, Two-Component Coating System (System below corresponds to MPI INT 3.2K):
  - 1) Prime Coat: Two-component, aliphatic polyurethane, clear, MPI #78.
  - 2) Intermediate Coat: Not required **OR** Two-component, aliphatic polyurethane, clear, MPI #78, **as directed**.
  - 3) Topcoat: Two-component, aliphatic polyurethane, clear, MPI #78.
4. Clay-Masonry Substrates:
  - a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 4.1L):
    - 1) Prime Coat: High-performance architectural latex matching topcoat.
    - 2) Intermediate Coat: Not required **OR** High-performance architectural latex matching topcoat, **as directed**.
    - 3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.
  - b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 4.1C):
    - 1) Prime Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.
    - 2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
    - 3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
  - c. Epoxy Coating System (System below corresponds to MPI INT 4.1F) (MPI recommends this system for smooth brick.):
    - 1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
    - 2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
    - 3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
  - d. Water-Based Epoxy Coating System (System below corresponds to MPI INT 4.1G) (MPI recommends this system for smooth brick.):
    - 1) Prime Coat: Water-based epoxy (interior and exterior), MPI #115.
    - 2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
    - 3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.
  - e. Polyurethane, Clear, Two-Component Coating System (System below corresponds to MPI INT 4.1K):
    - 1) Prime Coat: Two-component, aliphatic polyurethane, clear, MPI #78.
    - 2) Intermediate Coat: Not required **OR** Two-component, aliphatic polyurethane, clear, MPI #78, **as directed**.
    - 3) Topcoat: Two-component, aliphatic polyurethane, clear, MPI #78.
5. CMU Substrates:
  - a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 4.2D):
    - 1) Prime Coat: Interior/exterior latex block filler, MPI #4.
    - 2) Intermediate Coat: Not required **OR** High-performance architectural latex matching topcoat, **as directed**.
    - 3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.
  - b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 4.2K):
    - 1) Prime Coat: Interior/exterior latex block filler, MPI #4.



- 2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
  - 3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
  - c. Epoxy Coating System (System below corresponds to MPI INT 4.2F and MPI INT 4.2G, depending on primer selected) (MPI recommends these systems for dry environments.):
    - 1) Prime Coat: Interior/exterior latex block filler, MPI #4 **OR** Epoxy block filler, MPI #116, **as directed**.
    - 2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
    - 3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
  - d. Water-Based Epoxy Coating System (System below corresponds to MPI INT 4.2J) (MPI recommends this system for wet environments.):
    - 1) Prime Coat: Interior/exterior latex block filler, MPI #4.
    - 2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
    - 3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.
6. Steel Substrates:
- a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 5.1R):
    - 1) Prime Coat: Alkyd anticorrosive metal primer, MPI #79 **OR** Quick-dry alkyd metal primer, MPI #76, **as directed**.
    - 2) Intermediate Coat: Not required **OR** High-performance architectural latex matching topcoat, **as directed**.
    - 3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.
  - b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 5.1B and MPI INT 5.1N, depending on primer selected.):
    - 1) Prime Coat: Rust-inhibitive primer (water based), MPI #107 **OR** Cold-curing epoxy primer, MPI #101, **as directed**.
    - 2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
    - 3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
  - c. High-Build Epoxy Coating System - Premium Grade (System below corresponds to MPI INT 5.1P):
    - 1) Prime Coat: Epoxy zinc primer, MPI#20.
    - 2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
    - 3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
  - d. High-Build Epoxy Coating System – Custom Grade (System below corresponds to MPI INT 5.1P):
    - 1) Prime Coat: Epoxy zinc primer, MPI#20.
    - 2) Topcoat: High-build epoxy marine coating, low gloss, MPI #108.
  - e. Epoxy Coating System (System below corresponds to MPI INT 5.1L):
    - 1) Prime Coat: Cold-curing epoxy primer, MPI #101.
    - 2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
    - 3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
  - f. Water-Based Epoxy Coating System (System below corresponds to MPI INT 5.1K):
    - 1) Prime Coat: Rust-inhibitive primer (water based), MPI #107.
    - 2) Intermediate Coat: Water-based epoxy (interior and exterior), MPI #115.
    - 3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.
  - g. Polyurethane, Pigmented Coating System (System below corresponds to MPI INT 5.1F):
    - 1) Prime Coat: Cold-curing epoxy primer, MPI #101.



- 2) Intermediate Coat: Not required **OR** Polyurethane, two-component, pigmented, gloss, MPI #72, **as directed**.
- 3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
- h. Polyurethane, Pigmented Coating System (System below corresponds to MPI INT 5.1H):
  - 1) Prime Coat: Inorganic zinc primer, MPI #19.
  - 2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
  - 3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
- i. Polyurethane, Pigmented Coating System (System below corresponds to MPI INT 5.1J):
  - 1) Prime Coat: Epoxy zinc primer, MPI#20.
  - 2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
  - 3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
- j. Polyurethane, Pigmented, Over High-Build Epoxy Coating System (System below corresponds to MPI INT 5.1G):
  - 1) Prime Coat: Cold-curing epoxy primer, MPI #101.
  - 2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
  - 3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
7. Galvanized-Metal Substrates:
  - a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 5.3M):
    - 1) Prime Coat: Waterborne galvanized-metal primer, MPI #134.
    - 2) Intermediate Coat: Not required **OR** High-performance architectural latex matching topcoat, **as directed**.
    - 3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.
  - b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 5.3B and MPI INT 5.3K, depending on primer selected.):
    - 1) Prime Coat: Cementitious galvanized-metal primer, MPI #26 **OR** Waterborne galvanized-metal primer, MPI #134, **as directed**.
    - 2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
    - 3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
  - c. Epoxy Coating System (System below corresponds to MPI INT 5.3D):
    - 1) Prime Coat: Cold-curing epoxy primer, MPI #101.
    - 2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
    - 3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
8. Aluminum (Not Anodized or Otherwise Coated) Substrates (System below corresponds to MPI INT 5.4F):
  - a. High-Performance Architectural Latex Coating System:
    - 1) Prime Coat: Quick-drying primer for aluminum, MPI #95.
    - 2) Intermediate Coat: Not required **OR** High-performance architectural latex, matching topcoat, **as directed**.
    - 3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.
  - b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 5.4E):
    - 1) Prime Coat: Quick-drying primer for aluminum, MPI #95.
    - 2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
    - 3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
  - c. Epoxy Coating System (System below corresponds to MPI INT 5.4B):



- 1) Prime Coat: Vinyl wash primer, MPI #80.
  - 2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
  - 3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
- d. Polyurethane, Pigmented Coating System (System below corresponds to MPI INT 5.4C):
- 1) Prime Coat: Vinyl wash primer, MPI #80.
  - 2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
  - 3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
9. Wood Substrates:
- a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 6.1N, MPI INT 6.3A, and MPI INT 6.4S):
- 1) Prime Coat: Interior latex-based wood primer, MPI #39.
  - 2) Intermediate Coat: High-performance architectural latex matching topcoat.
  - 3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.
- b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 6.3P and MPI INT 6.4N):
- 1) Prime Coat: Interior alkyd primer/sealer, MPI #45.
  - 2) Intermediate Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.
  - 3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
- c. Epoxy Coating System (System below corresponds to MPI INT 6.1L and MPI INT 6.3L):
- 1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
  - 2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
  - 3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
- d. Pigmented Polyurethane Coating System (System below corresponds to MPI INT 6.1E):
- 1) Prime Coat: Polyurethane, two-component, pigmented, gloss, MPI #72.
  - 2) Intermediate Coat: Polyurethane, two-component, pigmented, gloss, MPI #72.
  - 3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
- e. Polyurethane, Clear, Moisture-Cured Coating System (System below corresponds to MPI INT 6.1S, MPI INT 6.2N, MPI INT 6.3Y, and MPI INT 6.4V):
- 1) Stain Coat: Interior wood stain, semitransparent (solvent based), MPI #90.
  - 2) Intermediate Coat: Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed**.
  - 3) First Topcoat: Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed**.
  - 4) Second Topcoat: Not required **OR** Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed**.
- f. Polyurethane, Clear, Moisture-Cured Coating System (System below corresponds to MPI INT 6.3X):
- 1) Intermediate Coat: Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed**.
  - 2) First Topcoat: Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed**.
  - 3) Second Topcoat: Not required **OR** Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed**.
- g. Polyurethane, Clear, Two-Component Coating System (System below corresponds to MPI INT 6.3Z):
- 1) Stain Coat: Exterior semitransparent stain (solvent based), MPI #13.
  - 2) Intermediate Coat: Not required **OR** Two-component, aliphatic polyurethane, clear, MPI #78, **as directed**.
  - 3) Topcoat: Two-component, aliphatic polyurethane, clear, MPI #78.
10. Gypsum Board Substrates:



- a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 9.2B):
  - 1) Prime Coat: Interior latex primer/sealer, MPI #50.
  - 2) Intermediate Coat: High-performance architectural latex matching topcoat.
  - 3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.
- b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 9.2L):
  - 1) Prime Coat: Interior latex primer/sealer, MPI #50.
  - 2) Intermediate Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.
  - 3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
- c. Epoxy Coating System (System below corresponds to MPI INT 9.2E):
  - 1) Prime Coat: Interior latex primer/sealer, MPI #50.
  - 2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
  - 3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
- d. Water-Based Epoxy Coating System (System below corresponds to MPI INT 9.2F):
  - 1) Prime Coat: Interior latex primer/sealer, MPI #50.
  - 2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
  - 3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.

END OF SECTION 09 96 00 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
09 96 53 00	09 91 13 00	Exterior Painting

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## SECTION 09 96 56 00 - FIBERGLASS REINFORCED EPOXY COATING

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Submittals

1. Product Data: For each coating system specified.

#### C. Material Storage

1. Store materials in a temperature controlled environment (50°F - 90°F) and out of direct sunlight.
2. Keep resins, hardeners, and solvents separated from each other and away from sources of ignition. One year shelf life is expected for products stored between 50°F - 90°F.

### 1.2 PRODUCTS

#### A. Materials

1. Multi-Layer, High Build Wall and Ceiling Surfacing System
  - a. Primer
    - 1) Water-based epoxy base coating.
  - b. Base Coat
    - 1) High performance epoxy coating.
  - c. Fiberglass Mesh Reinforcement
    - 1) Bound fiberglass cloth, 5.6 oz.
  - d. Saturant
    - 1) High performance epoxy coating.
  - e. Level Coat
    - 1) High performance epoxy coating.
  - f. Chemical Resistant Finish Coat
    - 1) 100% solids polyurethane.

### 1.3 EXECUTION

#### A. Primer

1. Mixing and Application: Water Based Epoxy Wall Coating should only be used on unpainted, porous surfaces. If the surface is painted with latex or an epoxy coating, clean and abrade the surface then apply the primer.
2. Premix resin and hardener separately, using a low speed drill and Jiffy mixer. Mix for three minutes and until uniform, exercising caution not to whip air into the materials.
3. Add 2 parts resin to 1 part hardener, mix with low speed drill and Jiffy mixer for three minutes and until uniform. Apply material using a 1/4" short nap roller at a spread rate of 300-350 sq. ft. per gallon to yield 5 mils WFT.
4. Allow to cure for a minimum of 3 hours depending upon air movement. Lightly "pole sand" smooth rough edges of the flake before applying base coat.

#### B. Base Coat

1. Mixing and Application



- a. Premix resin and hardener separately, using a low speed drill and Jiffy mixer. Mix for three minutes and until uniform, exercising caution not to introduce air into the material.
  - b. Add 3 parts resin to 1 part hardener by volume. Mix with low speed drill and Jiffy mixer for three minutes and until uniform. To insure proper system cure and performance, strictly follow mix ratio recommendations.
  - c. Base coat may be applied via spray, roller or brush. Apply using a 1/4" nap roller at a spread rate of 200-250 sq. ft. per gallon to yield 6-8 mils WFT evenly with no runs. Coverage will vary depending upon porosity of the substrate and surface texture.
- C. Fiberglass Reinforcement
1. Apply 5.6 oz. bound fiberglass cloth for walls and 4 oz. for ceilings directly into wet resin. Do not allow material to cure or recoating will be necessary.
  2. Hang fiberglass cloth directly to the wall similar to hanging wallpaper so seams are uniform and even. Overlap each strip using a double cut method. Remove the trimmed material behind the front strip.
  3. After hand affixing to wall, use a broad knife to remove air pockets, wrinkles or any irregularities.
- D. Saturant Coat
1. Mixing and Application
    - a. Premix resin and hardener separately, using a low speed drill and Jiffy mixer. Mix for three minutes and until uniform, exercising caution not to introduce air into the material.
    - b. Add 3 parts 3548PA (resin) to 1 part 3548B (hardener) by volume. Mix with low speed drill and Jiffy mixer for three minutes and until uniform. To insure proper system cure and performance, strictly follow mix ratio recommendations.
    - c. Saturant coat may be applied via spray, roller or brush. Apply at a spread rate of 250-400 sq. ft. per gallon to yield 4-6 mils WFT evenly with no runs. Allow to cure overnight (minimum 10 hours) before lightly sanding seams, bumps and other imperfections with 60-80 grit sandpaper caused by the saturant coat.
- E. Level Coat
1. Mixing and Application
    - a. Apply leveling coat as described in previous step.
    - b. Allow to cure overnight.
    - c. An additional level coat may be applied.
    - d. Sand any imperfections prior to applying finish coat.
- F. Finish Coat
1. Mixing and Application
    - a. Premix resin using a low speed drill and Jiffy mixer. Mix for three minutes and until uniform, exercising caution not to introduce air into the material.
    - b. Add 1 part resin to 1 part hardener by volume. Mix with low speed drill and Jiffy mixer for three minutes and until uniform. To insure proper system cure and performance, strictly follow mix ratio recommendations.
    - c. Finish coat may be applied via spray, roller or brush. Apply using a 1/4" nap non-shedding, urethane enamel roller at a spread rate of 250-400 sq. ft. per gallon to yield 4-6 WFT mils evenly with no runs. If second coat is required, the surface must be abraded with 80-120 grit paper or screen and tack wiped prior to second application.
    - d. Allow to cure 48 hours for water exposure and 7 days for chemical exposure. In cool and/or high humidity conditions, a surface film may form which can be washed with soap and water.

END OF SECTION 09 96 56 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
09 96 56 00	09 96 00 00	High-Performance Coatings

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## SECTION 09 96 66 00 - CEMENTITIOUS COATINGS

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. Section includes surface preparation and application of cementitious coating systems on the following substrates:
  - a. Exterior and Interior concrete.
  - b. Exterior and Interior concrete masonry units.
  - c. Exterior and Interior brick.

#### C. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittal:
  - a. Product Data for Credit EQ 4.2: For paints and coatings, including printed statement of VOC content and chemical components.
3. Samples: In each color and gloss of finish coat indicated.
  - a. Submit Samples on rigid backing **OR** actual substrate, **as directed**, not less than 4 by 8 inches (100 by 200 mm), with mortar joint in center, **as directed**.
  - b. Step coats on Samples to show each coat required for system.
  - c. Label each coat of each Sample.
4. Material Certificates: For each cementitious coating, from manufacturer.
5. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency or by a qualified testing agency, for each product formulation.

#### D. Quality Assurance

1. Source Limitations: Obtain cementitious coating materials from single source from single manufacturer.
2. Mockups: Apply benchmark samples of coating 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 actual substrate of each type to represent surfaces and conditions for application of coating.
    - 1) Wall Surfaces: Prepare samples of at least 100 sq. ft. (9.3 sq. m).
  - b. Apply benchmark samples after permanent lighting and other environmental services have been activated.
  - c. Final approval of color selections will be based on benchmark samples.
    - 1) If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.

#### E. Delivery, Storage, And Handling

1. Deliver materials to Project site in manufacturer's original, new, unopened packages and containers bearing manufacturer's name and label, and the following information:
  - a. Product name or title of material.
  - b. Manufacturer's stock number and date of manufacture.
  - c. Contents by volume, for pigment and vehicle constituents.
  - d. Application instructions.



- e. Color name and number.
- f. Handling instructions and precautions.
- 2. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F (7 deg C). Maintain containers used in storage of coatings in a clean condition, free of foreign materials and residue.
  - a. Protect cementitious coating materials from freezing. Keep materials dry and storage area neat and orderly. Remove waste daily. Take necessary measures to ensure that workers and work areas are protected from health hazards resulting from handling, mixing, and applying the coating.

#### F. Project Conditions

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

## 1.2 PRODUCTS

### A. Cementitious Coatings

- 1. Polymer-Modified Cementitious Coating: Containing portland cement, polymer, and hydrated lime or aggregates.
- 2. Performance Requirements: Comply with the following:
  - a. Compressive Strength: Not less than 3500 psi (24.1 MPa) at 28 days according to ASTM C 109/C 109M.
  - b. Tensile Strength: Not less than 350 psi (2.41 MPa) at 28 days according to ASTM C 109/C 109M.
  - c. Flexural Strength: as directed by the Owner.
  - d. Adhesion: as directed by the Owner.
  - e. Permeance: as directed by the Owner.
  - f. Accelerated Weathering: as directed by the Owner.
  - g. UV Resistance: as directed by the Owner.
  - h. Salt-Spray Resistance: as directed by the Owner.
- 3. Other Materials: Provide crack fillers, block fillers, and related materials that are compatible with cementitious finish-coat materials and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
- 4. Chemical Components of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions:
  - a. Flat Paints and Coatings: VOC content of not more than 50 g/L.
  - b. Nonflat Paints and Coatings: VOC content of not more than 150 g/L.
- 5. Chemical Components of Interior Paints and Coatings: Provide topcoat paints that comply with the following chemical restrictions:
  - a. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
  - b. Restricted Components: Paints and coatings shall not contain any of the following:
    - 1) Acrolein.
    - 2) Acrylonitrile.
    - 3) Antimony.
    - 4) Benzene.
    - 5) Butyl benzyl phthalate.
    - 6) Cadmium.
    - 7) Di (2-ethylhexyl) phthalate.



- 8) Di-n-butyl phthalate.
  - 9) Di-n-octyl phthalate.
  - 10) 1,2-dichlorobenzene.
  - 11) Diethyl phthalate.
  - 12) Dimethyl phthalate.
  - 13) Ethylbenzene.
  - 14) Formaldehyde.
  - 15) Hexavalent chromium.
  - 16) Isophorone.
  - 17) Lead.
  - 18) Mercury.
  - 19) Methyl ethyl ketone.
  - 20) Methyl isobutyl ketone.
  - 21) Methylene chloride.
  - 22) Naphthalene.
  - 23) Toluene (methylbenzene).
  - 24) 1,1,1-trichloroethane.
  - 25) Vinyl chloride.
6. Colors: As selected from manufacturer's full range **OR** As indicated in a color schedule, **as directed**.

### 1.3 EXECUTION

#### A. Examination

1. Examine substrates and conditions, with Applicator present, for compliance with requirements and other conditions affecting performance of the Work.
2. Verify suitability of substrates, including surface conditions and compatibility.
3. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
  - a. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

#### B. Preparation

1. Comply with manufacturer's written instructions for mixing and preparing materials and as applicable to substrates indicated.
2. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
  - a. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
3. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, incompatible coatings, and loose substrate materials.
4. Cementitious and Masonry Surfaces: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
5. Crack Repair: Fill cracks according to manufacturer's written instructions before coating surfaces.
  - a. Cracks Larger Than 1/32 Inch (0.8 mm): Cut out static cracks, voids, or honeycombing larger than 1/32 inch (0.8 mm) and patch with materials recommended in writing by coating manufacturer. Identify dynamic cracks and treat according to manufacturer's written instructions before beginning application.

#### C. Application

1. Apply coatings according to manufacturer's written instructions. Use applicators and techniques suited for coating and substrate indicated.



- a. Dampen substrate of surfaces to receive cementitious coatings one hour before beginning application to prevent surface drag. Immediately before applying coatings, redampen substrate. Substrates shall be saturated surface dry at time of application.
  - b. Brushes: Use tampico or masonry brushes best suited for material being applied.
  - c. Spray Equipment: Use spray equipment recommended in writing by manufacturer for material and texture required.
2. Apply each material at not less than manufacturer's recommended spreading rate. Provide total cured material thickness indicated or as recommended in writing by manufacturer.
  3. Brush Application: Brush-out and work brush coats into surfaces in an even film, filling all pores and voids at rate recommended in writing by manufacturer to achieve cured material thickness indicated. Finish coat with smooth, horizontal strokes.
  4. Spray Application: Apply each coat according to manufacturer's written instructions to provide the equivalent hiding of brush-applied coats. Follow spray application with a general light brooming of coated surface to impart a slight texture.
- D. Field Quality Control
1. Testing of Coating Materials: Contractor shall invoke the following procedure at any time and as often as necessary during the period when coating operations are being conducted:
    - a. Engage the services of a qualified testing agency to sample coating materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
    - b. Testing agency will perform tests for compliance with the following product requirements.
      - 1) Quantitative material analysis.
      - 2) Compressive strength.
      - 3) Tensile strength.
      - 4) Flexural strength.
      - 5) Permeance.
      - 6) Accelerated weathering.
    - c. the Owner may direct Contractor to stop coating application if test results show materials being used do not comply with requirements. Contractor shall remove noncomplying materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.
- E. Cleaning And Protection
1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
  2. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
  3. Protect work of other trades against damage from coating application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by the Owner, and leave in an undamaged condition.
  4. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.
- F. Coating Schedule
1. General: Apply additional coats when undercoats or other conditions show through final coat until cured film is of uniform coating finish, color, and appearance.
  2. Above-Grade Concrete and Masonry: Two finish coats with total cured thickness not less than 40 mils (1.0 mm).
    - a. First Coat: Apply polymer-modified cementitious coating material at the rate of 2 lb/sq. yd. (1 kg/sq. m) to achieve a total cured thickness of 25 mils (0.6 mm).
    - b. Second Coat: Apply polymer-modified cementitious coating material at the rate of 1 lb/sq. yd. (0.5 kg/sq. m) to achieve a total cured thickness of 15 mils (0.4 mm).



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3. Surfaces Previously Coated with Polymer-Modified Cementitious Coating: One finish coat with a total cured thickness of not less than 15 mils (0.4 mm).
    - a. Apply polymer-modified cementitious coating material at the rate of 1 lb/sq. yd. (0.5 kg/sq. m) to achieve a total cured thickness of 15 mils (0.4 mm).

END OF SECTION 09 96 66 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
09 97 13 23	09 96 00 00	High-Performance Coatings
09 97 13 24	09 96 00 00	High-Performance Coatings
09 97 26 13	09 96 00 00	High-Performance Coatings
09 97 35 00	09 91 23 00	Interior Painting
09 97 63 00	09 96 00 00	High-Performance Coatings



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 01 30 91	01 22 16 00	No Specification Required
26 01 50 51	01 22 16 00	No Specification Required
26 01 50 51	02 84 16 00	Removal of Fluorescent Light Ballasts/Capacitors and Fluorescent Light Tubes
26 01 50 51	02 84 16 00a	Interior Lighting
26 01 50 51	02 84 16 00b	Exterior Lighting
26 01 50 52	02 84 16 00	Removal of Fluorescent Light Ballasts/Capacitors and Fluorescent Light Tubes
26 01 50 52	02 84 16 00a	Interior Lighting
26 01 50 52	02 84 16 00b	Exterior Lighting
26 01 50 53	02 84 16 00	Removal of Fluorescent Light Ballasts/Capacitors and Fluorescent Light Tubes
26 01 50 53	02 84 16 00a	Interior Lighting
26 01 50 53	02 84 16 00b	Exterior Lighting



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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



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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".

END OF SECTION 26 05 00 00



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## SECTION 26 05 13 00 - 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** Aluminum 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 13 00



## SECTION 26 05 13 00a - 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 13 00a



## SECTION 26 05 13 00b - 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 13 00b



## SECTION 26 05 19 13 - 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 19 13



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 05 19 13	26 05 13 00a	Undercarpet Cables

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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



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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.



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 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).
- 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) GFIC 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 - 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.
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.



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- 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 19 16c

**SECTION 26 05 19 16d - 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.
  - a. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD **OR** RCDD/NTS **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** 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.

END OF SECTION 26 05 19 16d



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## SECTION 26 05 19 16e - 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.
  - a. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
  - 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.



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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 16e

**SECTION 26 05 19 16f - 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.
  - a. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
  - 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 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. 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 16f

**SECTION 26 05 19 16g - 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 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 16g



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 05 19 16	01 22 16 00	No Specification Required
26 05 19 16	26 05 00 00	Common Work Results for Electrical
26 05 19 16	26 05 13 00	Conductors And Cables
26 05 19 16	26 05 13 00a	Undercarpet Cables
26 05 19 16	26 05 13 00b	Medium-Voltage Cables



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## SECTION 26 05 19 23 - MONORAILS WITH ELECTRIC POWERED HOISTS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for monorails with electric powered hoists. 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. System Description

1. Provide a monorail system with electric powered hoist(s) and plain type (hand operated) **OR** hand chain operated **OR** electric powered, **as directed**, trolley(s) complete, tested and ready for operation. Monorails, hoist(s), trolley(s), equipment, materials, installation, examination, inspection, and workmanship shall be in accordance with the applicable requirements of NFPA 70, ASME/ANSI B30.11, ASME/ANSI B30.16, ASME HST-1M, ANSI/ASME HST-4M, and MMA MH27.1, with modifications specified herein. Reference in these publications to the "authority having jurisdiction" shall be interpreted to mean the "the Owner."

#### C. Submittals

1. Shop Drawings: Monorail system
2. Product Data: Monorail track system including switches, suspension system and other components; Electric wire rope hoist; Electric chain hoist; Trolley; Pendant pushbutton station; Electrification.
3. Design Data: Load and sizing calculations.
4. Test Reports
5. Certificates
6. Operation and Maintenance Data

#### D. Delivery, Storage, and Handling

1. Delivery and Storage: Inspect materials delivered to site for damage; unload and store with minimum handling. Store materials on-site in enclosures or under protective coverings. Protect materials not suitable for outdoor storage to prevent damage during periods of inclement weather, including subfreezing temperatures, precipitation, and high winds. Store materials susceptible to deterioration by direct sunlight under cover and avoid damage due to high temperatures. Do not store materials directly on ground. When special precautions are required, prominently and legibly stencil instructions for such precautions on outside of equipment or its crating.
2. Handling: Handle materials in such a manner as to ensure delivery to final location in undamaged condition. Make repairs to damaged materials at no cost to the Owner.

#### E. Quality Assurance

1. Certificates: Overload Test Certificate: Submit a statement that the monorail system can be periodically load tested to 125 percent (plus 5 minus 0) of rated load.
2. Drawings: Monorail System: Show the general arrangement of all components, clearances and principal dimensions, assemblies of hoist, trolley, track, track suspension system, and electrical schematic drawings.
3. Design Data: Load and Sizing Calculations: Submit calculations verifying the sizing of any track, track suspension device and additional supports which are not the monorail system manufacturer's standard cataloged product.

### 1.2 PRODUCTS



- A. Overhead Monorail System: Provide overhead monorail system conforming to MMA MH27.1, Class C, for indoor **OR** outdoor, **as directed**, service, with an electric wire rope or chain hoist mounted on a movable trolley. Trolley shall be plain type (hand operated) **OR** hand chain operated **OR** motor operated, **as directed**. Monorail system shall operate on AC voltage as required to meet project requirements, 60 Hz, single **OR** three, **as directed**, phase power source.
1. Capacity: The monorail system shall have a minimum rated capacity as required to meet project requirements. Mark the hoist capacity in pounds (kg) on both sides of the hoist or load block.
  2. Speeds: The hoist shall have two operating speeds, **unless directed otherwise**, and shall be capable of hoisting and lowering the rated load at a high speed of 20 feet per minute (fpm) (100 mm/s). The trolley shall have two operating speeds, **unless directed otherwise**, and shall be capable of moving the rated load at a high speed of 50 fpm **OR** 100 fpm, **as directed**, (250 mm/s **OR** 500 mm/s, **as directed**,). Low speed(s) shall be one quarter to one third of high speed(s). Actual speed(s) shall be within plus or minus 15 percent of those specified.
  3. Material Limitations: Shafts, keys, couplings, sprockets, and chains shall be steel. All gears shall be steel except for worm gears, which shall be bronze or steel. Cast iron and aluminum used to support components of the hoist power transmission train shall be ductile.
  4. Safety: Comply with the mandatory and advisory safety requirements of ASME/ANSI B30.11, ASME/ANSI B30.16, and 29 CFR 1910.179.
- B. Monorail Track System: MMA MH27.1. Track beams shall be patented track sections fabricated by a manufacturer regularly engaged in production of this type of beam.
1. Track Suspension System: Monorail suspension shall be flexible **OR** rigid, **as directed**, type. Make bolted connections to supporting structure, excluding hanger rods, with ASTM A 325/A 325M bolts, ASTM A 563/A 563M nuts, and ASTM F 959/F 959M load indicator washers. ASTM A 325/A 325M bolts shall be fully pre-tensioned in accordance with AISC S329. Support monorail track system from the structural members shown. Provide additional supports as required to carry monorail track system loads to the structural members shown. Materials for additional supports shall conform to the material requirements contained in Division 05 Section "Structural Steel Framing".
- C. Electric Wire Rope Hoist: ANSI/ASME HST-4M, Class H3, except as modified herein. Hoist shall be double reeved, **unless directed otherwise**.
1. Hoisting Ropes: FS RR-W-410, improved or extra improved plow steel, regular lay, uncoated, 6 by 37 class construction, with an independent wire rope core. Provide proof of wire rope breaking strength test report.
  2. Sheaves: Sheaves shall be steel or ductile cast iron. Pitch diameter of running sheaves shall not be less than 16 times the rope diameter. Pitch diameter of non running sheaves shall not be less than 12 times the rope diameter.
  3. Drum: Drum shall be steel or ductile cast iron. Pitch diameter of the drum shall not be less than 18 times the rope diameter. Not less than two dead wraps of the hoisting rope shall remain on each anchorage when the hook is in its extreme low position.
- D. Electric Chain Hoist: ASME HST-1M, Class H3, except as modified herein. Provide load chain proof test.
- E. Trolley: Trolley shall meet all applicable requirements of MMA MH27.1, ASME HST-1M and ANSI/ASME HST-4M. Trolley shall have elastomeric bumpers to engage runway stops.
- F. Motors: NEMA MG 1. Hoist motor shall be single **OR** two, **as directed**, speed AC squirrel cage induction type. Trolley motor shall be single **OR** two, **as directed**, speed AC squirrel cage induction type. Motor insulation shall be Class B minimum. Provide totally enclosed non-ventilated (TENV) motor enclosures. Maximum motor speed shall not exceed 1800 RPM.



- G. Controls: Provide single **OR** two, **as directed**, speed magnetic control for the hoist. Provide single **OR** two, **as directed**, speed magnetic controls for the trolley. Provide reduced voltage starting, acceleration and deceleration for the trolley drive.
- H. Limit Switches: Provide upper and lower limit switches which de-energize the hoist motor.
- I. Brakes: Provide hoist with an electro-mechanical holding brake and a mechanical load brake, each capable of holding 130 percent of the rated hoist capacity. Hoist holding brake shall be capable of being released to test the load brake. Provide trolley with an electro-mechanical brake. Provide trolley brake with a minimum torque rating of 100 percent (for outdoor monorails) or 50 percent (for indoor monorails) of the drive motor rated torque. Trolley brake torque shall be adjustable down to 85 percent of its torque rating.
- J. Load Block And Hook: Construct load blocks of steel. Provide forged steel, swivel type hook, with hook nut keyed to hook shank by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or other similar easily removable securing device. Hook throat opening shall not be less than as required to meet project requirements. Provide hook with spring loaded steel safety latch for closing the hook throat opening. The hook and hook nut shall be unpainted. Permanently mark hook and hook nut with an identification number.
1. Hook and Hook Nut Magnetic Particle Inspection: Magnetic particle inspect the hook and nut over the entire area in accordance with ASTM A 275/A 275M. Acceptance standard shall be no defects. A defect is defined as a linear indication that is greater than 1/8 inch (3 mm) long whose length is equal to or greater than three times it width.
- K. Bearings: All bearings except those subject to a small rocker motion shall be anti-friction type. Bearings not considered lifetime lubricated by the manufacturer shall be provided with a means for lubrication.
- L. Pendant Pushbutton Station: Hoist and trolley, **unless directed otherwise**, shall be controlled from a pendant pushbutton station. Arrange pushbuttons in accordance with ASME/ANSI B30.11 recommendations. Locate station 4 feet (1.2 m) above the finished floor
- M. Electrification: Runway electrification shall be of the flat festooned type **OR** enclosed safety bar type, **as directed**, with four continuous copper conductors. Provide electrical work for the monorail system in accordance with NFPA 70.
- N. Identification Plates: Provide identification plates of noncorrosive metal with clearly legible permanent lettering giving the manufacturer's name, model number, capacity in pounds, and other essential information or identification.
- O. Painting System: Painting shall be manufacturers standard. Provide a primer and a finish coat. For outdoor monorail systems, blast clean all components prior to painting and prime with inorganic zinc type primer; finish coat shall be an epoxy formulated for marine environments. Paint coats shall be smooth and even, free of runs, sags, orange peel, or other defects.
- 1.3 EXECUTION:
- A. Erection And Installation: Erect and install the monorail system, complete in accordance with the approved submittals and in condition to perform the operational and acceptance tests.
- B. Erection Services: Provide supervisory erection services from the monorail system manufacturer.
- C. Field Quality Control
1. Post-Erection Inspection: After erection, the Contractor and the the Owner shall jointly inspect the monorail and hoist systems and components to determine compliance with specifications and



- approved submittals. The Contractor shall notify the the Owner 3 days before the inspection. Provide a report of the inspection indicating the monorail system is considered ready for operational tests
2. **Operational Tests:** After erection and inspection, test the hoist, and trolley as specified herein. Test the systems in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacturer, installation, and workmanship. Rectify all deficiencies disclosed by testing and retest the system or component to prove the monorail system is operational. The Contractor shall furnish loads for testing, operating personnel, instruments, and all other necessary apparatus. The the Owner will furnish loads for testing; the Contractor shall receive and transport the loads from a location not more than 100 miles (161 km) from the job site and shall return them to that location after the tests have been completed.
  3. **Test Data:** Record test data on appropriate test record forms suitable for retention for the life of the monorail system. Record operating and startup current measurements for electrical equipment (motors and coils) using appropriate instrumentation (i.e., clamp-on ammeters). Compare recorded values with design specifications or manufacturer's recommended values; abnormal differences (i.e., greater than 10 percent from manufacturer's or design values) shall be justified or appropriate adjustments performed. In addition, high temperatures or abnormal operation of any equipment or machinery shall be noted, investigated, and corrected. Record hoist and trolley speeds during each test cycle.
  4. **Hook Test:** Measure hook for hook throat spread before and after load test. Establish a throat dimension base measurement by installing two tram points and measuring the distance between these tram points (plus or minus 1/64 inch (0.4 mm)). Record this base dimension. Measure the distance between tram points before and after load test. An increase in the throat opening by more than 5 percent from the base measurement shall be cause for rejection.
  5. **No-Load Test**
    - a. **Hoist:** Raise the load hook the full operating lift distance and verify satisfactory operation of hoist, upper limit switch, lower limit switch, and the hoisting and lowering speeds. Operate the hoist at low and high speed in both directions.
    - b. **Trolley:** Operate trolley assembly the full length of the monorail in both directions. Operate trolley at low and high speed in each direction. Verify satisfactory operation and verify trolley speed. Operate all rail switches.
  6. **Load Test: 125 Percent (plus 5 percent minus 0) of rated capacity**
    - a. **Hoist Static Test:** Raise test load approximately one foot above the floor and hold for 10 minutes. Observe load lowering that may occur which will indicate malfunction of hoisting component or brake. Lower the test load to the floor until the hoist line is slack.
    - b. **Hoist Dynamic Test:** Raise the test load to approximately 5 feet (1.5 m) above the floor using both speed points in the process. Lower the load back to the floor using both speed points. Stop the test load at least once while lowering at high speed and observe proper brake operation. Wait 5 minutes, then repeat the above cycle.
    - c. **Load Brake Test:** Raise test load approximately 5 feet (1.5 m). With the hoist controller in the neutral position, release the holding brake. The load brake should hold the test load. Again with the holding brake in the released position, start the test load down at low speed and return the controller to off position as the test load lowers. The load brake should prevent the test load from accelerating. NOTE: It is not necessary for the load brake to halt the downward motion of the test load.
    - d. **Loss of Power Test:** Raise the test load approximately 3 feet (1 m) and while lowering test load at low speed, cut main power to hoist. Load should stop.
    - e. **Trolley Test:** With test load hoisted to a height of one foot (300 mm) above the floor, operate trolley the full distance of the monorail in both directions using both speed points in the process. Observe for any malfunctioning of the trolley assembly and monorail system. Operate all rail switches.
    - f. **Rated Load Speed Test:** With the hoist loaded to rated capacity, raise and lower the load verifying that the hoisting and lowering speeds are provided as specified. With the hoist loaded to rated capacity, operate trolley along the monorail beam verifying that the trolley



speed is provided as specified. Further, verify that the trolley stops in each direction within a distance (in feet) equal to 10 percent of rated capacity high speed (in feet per minute) when initially travelling at high speed and carrying the rated capacity load. Record voltage, amperage, hoisting and lowering speeds, trolley travel speed, and motor speed for each motor.

END OF SECTION 26 05 19 23



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**SECTION 26 05 19 23a - CRANES, OVERHEAD ELECTRIC, UNDERRUNNING (UNDER 20,000 POUNDS)**

## 1.1 GENERAL

## A. Description Of Work

1. This specification covers the furnishing and installation of materials for underrunning overhead electric cranes (under 20,000 pounds). Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

## B. Definitions

1. Bridge: That part of an overhead crane consisting of girder, end trucks, and drive mechanism which carries the trolley/hoist and travels in a direction parallel to the runway. (An auxiliary girder may be required to support over-hanging loads.)
2. Dead Loads: The loads on a structure which remain in a fixed position relative to the structure.
3. Girder: The principal horizontal beam of the crane bridge which supports the trolley/hoist and is supported by the end trucks.
4. Live Load: A load which moves relative to the structure under consideration.
5. Patented Track: A generic term referring to crane and monorail track built in accordance with MMA MH27.1 utilizing a composite track section incorporating a proprietary bottom flange shape.
6. Rated Load: For the purpose of this specification the rated load is defined as the maximum working load suspended under the load hook. Load block and ropes are not included in the rated load.
7. Runway: The track, beams, hangar rods, and structural supports on which the crane operates.
8. Standard Commercial Product: A product which is currently being sold, or previously has been sold, in substantial quantities to the general public, industry or Government in the course of normal business operations. Nominal quantities, such as models, samples, prototypes or experimental units do not meet this definition.
9. Trolley/Hoist: A combined unit consisting of a trolley, a wheeled mechanism which provides horizontal motion along the bridge girder, and a hoist, a machinery unit, suspended from the trolley, used for lifting and lowering a freely suspended load.
10. Underrunning (Underhung) Crane: An electric overhead traveling crane having the end trucks supported on runway.

## C. Submittals

1. Shop Drawings
  - a. Submit shop drawings in the Contractor's standard format and show the general arrangement of all components in plan, elevation, and end views; clearances, hook approaches on all four sides, and principal dimensions, demonstrating compliance with the clearances indicated; assemblies of hoists, trolley, and bridge drives; and electrical schematic wiring diagrams. Provide panel wiring diagrams and interconnection diagrams, include an integral "Bill of Materials" on each drawing. Provide weights of major components. Provide maximum wheel loads (without impact) and spacings that will be imparted to the runway track beams.
  - b. Submit erection drawings showing all match-marked details of field joints, erection procedures, alignment procedures and tolerances, lifting points, and any special precautions to be observed during crane erection.
  - c. Submit lubrication drawing showing all lubrication points, the type of lubricant to be used, and the frequency of lubrication. Provide a table on each drawing for documentation of future revisions.
2. Product Data: Submit data for standard items including trolley/hoist, controllers, couplings, push-button station, electrification, bridge motors and brakes.

Cranes, Overhead Electric, Underrunning (Under 20,000 Pounds)



3. Design Data: Submit calculations demonstrating compliance with all specification requirements.
4. Test Reports.
5. Operation and Maintenance Data.

D. Quality Assurance

1. Structural Steel Fabrication: Fabricate structural steel free of kinks and sharp bends. Shear and chip neatly and accurately. Provide square and true corners. Straighten material by methods that will not change material properties or cause fabrication scars.
2. Flame Cutting: Flame cutting, using a tip suitable for the thickness of metal, may be used instead of shearing or sawing. Grind or machine flame-cut surfaces sufficiently to remove slag, objectionable notches, and all evidence of cooling checks.
3. Forming: Make bends of major character with metal dies or fixtures to ensure uniformity of size and shape. Perform cold-forming operations with material temperature below 600 degrees F (310 degrees C). Perform hot-forming operations with material temperature over 1100 degrees F (590 degrees C).
4. Welding: AWS D14.1, including preweld and postweld heat treatments; however, the minimum classification of electrodes shall be the E70 series.
5. Castings: Make castings sound and free from warping, misplaced coring, or other defects which might render the casting defective. Perform weld repairs of castings to correct dimensions or other defects only after approval of such repairs is obtained from the the Owner. Make weld repairs items of permanent record.
6. Structural and Weldment Machining: Machine flat all mounting surfaces for electric motors, brakes, gear reducers, and other mechanical components. Finish mounting surfaces to 250 micro-inches (6 micrometers) or finer. Machine seats for travel wheel bearings, bearing housings, or pillow blocks with one set-up on a milling or boring machine.
7. Hook and Hook Nut Inspection
  - a. Magnetic-particle inspect the entire surface area in accordance with ASTM A 275/A 275M. Acceptance standard shall be no defects. A defect is defined as a linear indication that is greater than 1/8 inch (3 mm) long whose length is equal to or greater than three times its width.
  - b. Each hook, including shank and hook nut, shall be inspected over the entire surface areas by magnetic particle inspection. If hook nut is not used, any device that functions the same as the hook nut shall be inspected by magnetic particle inspection.
    - 1) Procedure: Magnetic particle inspection shall be conducted in accordance with ASTM A 275/A 275M. This inspection shall be conducted at the factory of the hook manufacturer or hoist manufacturer. Alternately, a recognized independent testing lab may conduct the inspections if equipped and competent to perform such a service, and if approved by the the Owner.
    - 2) Acceptance Criteria: Defects found on the hook or hook nut shall result in rejection of defective items for use on furnished hoist. For this inspection, a defect is defined as a linear or non-linear indication for which the largest dimension is greater than 1/8 inch (3 mm). Weld repairs for defects on hook or hook nut will not be permitted.
    - 3) Test Report: A test report of the magnetic particle inspection of each hook and hook nut provided shall be submitted to and approved by the the Owner prior to final acceptance of hoist installation. Test reports shall be certified by the testing organization.
    - 4) Weld Repair: Weld repairs for defects on hooks or hook nuts will not be acceptable.
8. Shop Structural Alignment: Accurately align girders and end trucks for squareness and parallelism prior to punching, drilling, and reaming bolt holes. Install bridge and trolley travel wheels with their respective axles parallel and in line side-to-side.
9. Structural Bolted Connections: Accurately punch, drill, and ream (as necessary) bolt holes, and remove burrs. Install ASTM A 325/A 325M bolts in accordance with AISC S329.
10. Machine Work (Structural and Mechanical Parts): Fabricate machined parts to the tolerances, surface finishes, and fits indicated on the approved drawings. Any surface indications of



- improper metal cutting or removal (such as tearing, glazing, smearing, or gouging) will be cause for rejection. Flaws such as scratches, ridges, holes, peaks, cracks, or checks which degrade the quality or suitability of a part, will be cause for rejection of such a part.
11. Mechanical Assembly: Accurately align (within coupling tolerances) and positively secure mechanical components to maintain the alignment. Shim gaps in excess of 0.001 inch (0.025 mm) under base-mounted components. A maximum of two shims per corner will be permitted. Do not force parts into position to obtain apparent alignment. Tighten bolts, nuts, and screws. Secure fasteners or parts which might become loosened by vibration, shock, or crane operation with suitable locking devices. Friction shall not be relied upon for retention of parts.
  12. Priming and Painting: The primer coats and the finish coat of paint shall be smooth, even, free of runs, sags, orange peels, or other defects. Care shall be taken to preclude painting over the hook, equipment information or name plates, lubrication fittings, stainless steel or aluminum, or mating surfaces of structural bolted connections. Paint, coatings, or galvanizing on the following items or areas will not be acceptable: hoist wire ropes, hook nuts, or areas on sheaves or rope drums in contact with the wire ropes.
  13. Electrical Installation: Install electrical wiring, conduit and components in accordance with the requirements of NFPA 70.
  14. Design Data
    - a. Girders
      - 1) For load Cases 1 and 2 (defined in CMAA 74) and load Cases 3 and 4 (defined herein), provide the following analyses:
        - a) Normal stress at mid-span including that due to warping;
        - b) Shear stress (including that due to torsion) at end notches;
        - c) Weld stresses;
        - d) Buckling (flange and web); and
        - e) Local flange bending (due to wheel loads).
      - 2) For Cases 1 and 2, provide fatigue analysis (welds and structural bolting and girder connections). Consider only unaltered ASTM A 325/A 325M bolts in this analysis.
      - 3) Using trolley load and lifting load, provide:
        - a) Calculation of mid-span deflection; and
        - b) Calculation of camber.
    - b. End Trucks: For each of the four load cases, provide the following analyses:
      - 1) Normal stresses;
      - 2) Shear stresses (including that due to torsion); and
      - 3) Weld stresses.
    - c. Structural Bolting at Girder Connections: For each of the four load cases, provide combined shear and tension stress calculations for girder-to-end truck connections.
  15. Test Reports: Requirements: Provide original mill test reports. Proof testing report of the hook as addressed in ASME/ANSI B30.10. Bolts shall meet requirements of ASTM A 325/A 325M. Nuts shall meet requirements of ASTM A 194/A 194M or ASTM A 563/A 563M. Submit complete heat treating records, mechanical test reports, and inspection test reports.

## 1.2 PRODUCTS

### A. General

1. Provide underrunning overhead electric crane with electrically operated bridge, trolley/hoist, controlled by a pendent pushbutton station suspended from a festooning system along the bridge. The crane shall, as a minimum, be in accordance with the requirements of this specification and shall be the manufacturer's standard commercial product. Include in the crane being furnished additional or better features which are not specifically prohibited by this specification, but which are a part of the manufacturer's standard commercial product. The crane shall operate in an indoor **OR** outdoor, **as directed**, environment. Maximum crane wheel loads (without impact) due to dead and live loads, with the trolley in any position, shall not cause a more severe loading



condition in the runway support structure than that produced by the design wheel loads and spacings indicated.

- a. Crane Safety: Comply with the mandatory and advisory safety requirements of ASME/ANSI B30.11, ASME/ANSI B30.16, and ANSI/ASME HST-4M.
- b. Power Characteristics: The crane shall operate from AC voltage as required to meet project requirements, 60 Hz three phase power source.

B. Capacity: The crane shall have a minimum rated capacity of 1/2 to 10 tons (one ton equals 2000 pounds) (1/2 to 10 metric tons), as required to meet project requirements.

C. Speeds: The crane shall have the following rated load speeds (plus or minus 15 percent):

1. Hoist - high speed of 10 feet per minute (fpm) (50 mm/s), unless otherwise directed.
2. Trolley - high speed of 50 fpm (250 mm/s).
3. Bridge - high speed of 50 fpm (250 mm/s).

D. Crane Design And Fabrication

1. Bridge: CMAA 74, Class C (Moderate Service) or MMA MH27.1, Class C (Moderate Service), except as modified herein. Provide a patented track for the girder.
2. Trolley: ANSI/ASME HST-4M, Class H3 or MMA MH27.1, Class C (Moderate Service), except as modified herein.
3. Hoist: ANSI/ASME HST-4M, Class H3, except as modified herein.
4. Structural Design: Design the crane in accordance with CMAA 74, except as modified herein. However, fabricate the girder from patented track conforming to MMA MH27.1.
  - a. Additional Load Combinations: In addition to load Case 1, "Crane in Regular Use Under Principal Loading" and Case 2, "Crane in Regular Use Under Principal and Additional Loading" of CMAA 74, also consider the following load combination(s):
    - 1) Test Loads: The crane will be periodically tested up to 130 percent of rated capacity. Calculate combined stresses for the following load combination to ensure structural adequacy during testing:

Case 3: Test Loads (Stress Level 3)

DL (DLFB) + TL (DLFT) + LL (1 + HLF) + IFD + SK

Note: LL = 1.3 x rated capacity

Test and extraordinary loads shall not be considered in the fatigue analysis

- 2) Seismic Forces (SF): Consider seismic forces in the design of the crane. Locate the concentrated load in the same positions as when calculating vertical shears and bending moments. Consider twisting moments due to the horizontal forces acting eccentric to the horizontal neutral axis of the girder in the shear and combined stress calculations. Do not consider seismic forces in the fatigue analysis. Calculate combined stresses due to seismic forces for the following load combination:

Case 4:

Seismic Loading (1.33 x Stress Level 1)

DL (DLFB) + TL (DLFT) + LL (1 + HLF) + SF

Note: Factor for SF to be as required to meet project requirements.

Note: SF = [\_\_\_\_\_] DL (distributed) + [\_\_\_\_\_] TL (concentrated)

- b. Welding: AWS D14.1 for welding design and procedures.
- c. Structural Bolted Connections: Attach girder to end truck with friction type connections and fasten with unaltered ASTM A 325/A 325M high-strength bolts. (Galvanized or coated



- bolts and ASTM A 490 bolts shall not be used.) Make structural bolted connections not referenced above with ASTM A 325/A 325M or ASTM A 307 bolts.
- d. Girder: Provide a patented track for the girder. The summation of all normal stresses on a girder section under analysis shall not exceed the allowable stress for tension or compression.
5. Mechanical Design: Provide crane bridge drive in accordance with MMA MH27.1. The hoist shall be trolley suspended and shall be in accordance with ANSI/ASME HST-4M and other requirements specified herein. Lift limiting and overload limiting devices which use a clutch to stop motion shall not be furnished with the hoist.
- a. Trolley Drive: Provide motor-driven type hoist trolley.
- b. Threaded Fastener: Fasten base-mounted and flange-mounted components and all mechanical connections subjected to calculable loads with ASTM A 325/A 325M bolts or SAE J 429, Grade 5, screws with properly torqued matched nuts. Bolts and screws may be installed into tapped holes only in heat treated steel with a minimum hardness of 195 BHN.
- c. Load Block: Construct the load block entirely of steel. The design shall preclude the wire rope from being cut, pinched, crushed, or chafed in case of two-blocking. Provide load block with a trunnion separate from the sheave pin. Bore the trunnion for swivel mounting of the hook and securely retain in the block side plates. The trunnion shall rotate about its horizontal axis in holes bored in the side plates. Construct the load block so that the hook and hook nut may be removed from the load block without disassembly of the block. Forge the hook from steel conforming to ASTM A 668/A 668M; the hook shall be unpainted. Provide the hook with a safety latch. Provide the equalizer bar or sheave perpendicular to the running sheaves. Mark hoist capacity in pounds on both sides of the load blocks. Hook and hook nut shall be capable of complete disassembly that enables access to all surfaces of hook, including shank and hook nut for inspection purposes. Provision shall be made for the hook nut, or other hook-to-block fastener, to be keyed to hook shank by means of a set screw or similar, easily removable, securing device. Paint the lower load block yellow, with one inch (25 mm) wide diagonal black stripes located on 2 inch (50 mm) centers.
- d. Hoisting Rope: FS RR-W-410, improved or extra improved plow steel, regular lay, uncoated, 6 by 37 class construction, with an independent wire rope core. Provide double reeved reeving arrangement. Connect hoisting rope dead end to equalizer bars (if used) by means of zinc-speltered sockets or swaged fittings installed in a manner which develops the full breaking strength of the hoisting rope. Anchor hoisting rope ends on the drum by means of swaged fittings or by clamping. Neatly and securely seize hoisting rope ends with corrosion resistant wire, except where terminated in zinc-speltered sockets or swaged fittings. Provide wire rope minimum safety factor of 5 to 1 based on the ratio of actual minimum wire rope breaking load to the calculated load on rope when hoist is assumed loaded to rated capacity. Certification from rope manufacturer verifying provided wire rope breaking strength, shall be submitted to the Owner and approved prior to final acceptance of hoist. No paint or coatings will be allowed on the wire rope. Minimum length of the wire rope shall enable the load hook to operate through its full hook lift range and still have a minimum of two full wraps of wire rope around the rope drum.
- e. Sheaves: Provide steel sheaves. Machine or grind the grooves to contour and rim toughen or flame or induction harden to not less than 320 BHN. Provide minimum pitch diameters of running sheaves of not less than 24 (for custom design load block with trunnion) or 16 (otherwise) times the rope diameter. Provide sheave groove depth of not less than 1.15 times the hoisting rope diameter.
- f. Drum: Provide drum with turned helical grooves cut right and left hand to receive, in a single layer, the full winding length of the rope plus not less than two dead wraps on each end.
- 1) The drum shall be of steel construction. Design drum so that not less than two dead wraps of hoisting rope will remain on each anchorage when the hook is in its extreme low position. Drum grooving shall be right and left hand. Minimum drum

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- groove depth, shall be 0.375 times the rope diameter. Minimum drum groove pitch shall be either 1.14 times the rope diameter, or the rope diameter plus 1/8 inch (3 mm), whichever is smaller. Minimum drum pitch diameter shall be 16 **OR** 18, **as directed**, times the rope diameter. The surface of the drum which comes in contact with wire rope shall not be painted, coated, or galvanized.
- g. Hoist Brake: Provide electro-mechanical holding brake and mechanical load brake.
  - h. Trolley Brake: Provide trolley drive with an electro-mechanical brake. Provide brake with a minimum torque rating of 100 percent (for outdoor crane) or 50 percent (for indoor crane) of the drive motor rated torque and adjustable down to 85 percent of its torque rating. Select disc brake (if applicable) having housing which permits easy access for wear and setting inspection of the friction discs.
  - i. Bridge Brake: Provide bridge drive with an electro-mechanical brake. Provide brake a minimum torque rating of 100 percent (for outdoor crane) or 50 percent (for indoor crane) of the drive motor rated torque and adjustable down to 85 percent of its torque rating. Select disc brake (if applicable) having housing which permits easy access for wear and setting inspection of the friction discs.
  - j. Bridge Drive: MMA MH27.1.
  - k. Bumpers: Provide elastomeric type bumpers on the trolley. Provide spring or elastomeric type bumpers, if bridge speed is 50 fpm (250 mm/s), or otherwise provide hydraulic type bumpers on bridge end trucks.
  - l. Surface Finishes: Finish mechanical components to 125 micro-inches (3 micrometers) or finer. Provide finer finishes as required by the component manufacturers.
  - m. Antifriction Bearings: Provide antifriction type bearings, except where bushings are specifically permitted or required. Provide grease lubricated bearings with means for relubrication through easily accessible lubrication fittings or provide permanently lubricated and sealed bearings.
  - n. Bushings: Provide manufacturer's standard bronze alloy bushings and thrust washers. Provide means for relubrication of grease lubricated bushings through easily accessible lubrication fittings or provide oil impregnated type bushings.
  - o. Shims: ASTM A 666, Type 304 corrosion resistant steel, pre-cut, slotted, and with the thickness stamped on an insert tab. Shim shape shall resemble a U and the slot width shall approximate the mounting bolt diameter.
6. Electrical Design: The design, selection, rating, and installation of the electrical portions of the crane and its accessories shall conform to the requirements of NEMA ICS 3, CMAA 74, ANSI/ASME HST-4M, and NFPA 70, and other requirements specified herein. Control each motion of the crane by a suitable controller. Design crane to operate on VAC rating as required to meet project requirements, 3-phase, 60-Hertz power. The crane manufacturer shall furnish and install all electrical equipment on the crane, including motors, electrically released brakes, switches, controllers, panels, operating station, wiring system, cables, and bridge-to-trolley electrification, and the runway electrification. Installation of the runway electrification includes providing conductors between the electrification system and the Owner installed junction box indicated. Provide NEMA Type 1 for indoor crane or Type 3 for outdoor crane, as defined by NEMA 250, enclosures for control panels, for pendent pushbutton station, and for auxiliary devices and mount along the bridge.
- a. Wiring System: Provide the wiring system, with all of its associated hardware, fittings, and devices, in accordance with NFPA 70. Provide type RHW, TFE, XHHW, or Z conductors in raceways and type SIS conductors on control panels. Provide type TFE or Z insulation for conductors connected to, or routed above, resistors. Provide ferrous rigid metal conduit raceways suitable for wet locations; where flexible connections are necessary, provide liquidtight flexible metal conduit. Provide an equipment grounding conductor, sized in accordance with Section 250-95 of NFPA 70, with all ungrounded conductors. Provide No. 4 AWG (25 mm<sup>2</sup>) minimum for leads from the runway contact conductors. Number or tag wiring at connection points.



- b. Motors: NEMA MG 1. Provide two speed (if magnetic controls are specified) or single speed (if electronic controls are specified) AC squirrel cage induction type motors for the bridge and trolley drives. Provide two speed, AC squirrel cage induction type motor for the hoist. Motor insulation shall be Class F. Provide totally enclosed non-ventilated (TENV) motor enclosures.
- c. AC Controls:
- 1) OPTION 1: Provide two-speed magnetic controls for the bridge drive, trolley drive, and hoist motors. Ensure that an energized drive motor initially rotates only in the direction selected by the operator by depressing the corresponding pushbutton; i.e., is not overhauled. Feed control circuits from a single phase, air cooled, double wound transformer with a grounded metal screen between the primary and secondary windings of the transformer.
    - a) Bridge and Trolley Control: Provide bridge drive and trolley drive motor control systems with resistive or reactive reduced voltage starting, acceleration, and deceleration utilizing, for each, separate banks of voltage reducing resistors or reactors and timing relays. On deceleration, insert the resistors or reactors into the motor's high speed leads prior to de-energization of the high speed contactor. Ensure smooth acceleration and deceleration. Provide bridge drive and trolley drive motor control systems with a drift point between OFF and the first speed control point in each direction.
    - b) Plugging Protection: Provide plugging protection for the bridge and trolley drives. Provide time delay relays, which will prevent the plugging of bridge and trolley drive motors, in the control circuit; arrange the controls to set the associated drive's brake if attempts are made to plug.

OR

OPTION 2: Provide two-speed magnetic controls for the hoist motor; provide four-speed adjustable frequency controls for the bridge and trolley drive motors. Ensure that an energized drive motor initially rotates only in the direction selected by the operator by depressing the corresponding pushbutton; i.e., is not overhauled.

- c) Bridge and Trolley Control: Provide static reversing, dynamic braking, adjustable frequency (achieved by sinusoidal pulse width modulation), constant torque controllers for the bridge and trolley drive motors. Size each of the controllers so as to provide sufficient starting torque to initiate motion of that crane drive from standstill with rated load under the hook. The acceleration time and the deceleration time shall be independently adjustable from 2 to 20 seconds; initially, set acceleration at 5 seconds and deceleration at 2 seconds. In each direction, provide a drift point between OFF and the first running speed point; provide four running speed points, namely 10, 33, 67, and 100 percent of rated speed. The motor shall run smoothly, without torque pulsations at the lowest speed, and shall be energized at a frequency not exceeding 60 Hz at the highest speed. Include with the controller a full wave rectifier and a three-phase inverter. Select diodes and power transistors so that their current ratings are not less than 200 percent of full load motor current. Provide motor overload protection utilizing a thermal sensitive device embedded in its windings.

Energize each crane drive's electro-mechanical brake by a dedicated contactor controlled directly by the pushbuttons on the pendant pushbutton station; i.e., when both of the pushbuttons for a drive are in the OFF position the brake shall be set and when either of them is in any drift or speed point position the brake shall be released. Provide dynamic braking. Connect resistors to the controller's DC bus whenever motor regeneration causes the DC voltage to rise to a predetermined unacceptable level. Provide resistors continuously rated at a minimum of 125 percent of the full load motor current.



- d) Hoist Control: Feed control circuit from a single phase, air cooled, double wound transformer with a grounded metal screen between the primary and secondary windings of the transformer.
- d. Protection: Not less than that required by NEMA ICS 3, CMAA 74, ANSI/ASME HST-4M, MMA MH27.1, and NFPA 70. Provide enclosed type circuit breaker for crane disconnect. The main line contactor shall be the floor operated disconnect.
- e. Operating Station: Control crane from a pendent pushbutton station. Suspend pendent pushbutton station, from a festooning system along the bridge, by a small cord strain lead 1/8 inch (3 mm) (minimum), 7 by 19 construction, made from corrosion resistant steel, and conforming to FS RR-W-410. Provide Type SO cable for pendent cable with a minimum of 20 percent of its conductors reserved as spares at the time of crane acceptance. On the pushbutton station, provide a blue pilot light to indicate that the main line contactor is energized and a white pilot light to indicate that power is available on the load side of the crane disconnect means. Energize the white pilot light by a separate, fused transformer. Assign cardinal points to bridge and trolley pushbuttons.
- f. Resistors: Provide resistors rated for continuous duty operation based upon the motor nameplate amperes (unless electronic controls are specified, in which case use 125 percent of the motor nameplate amperes) and fabricated of corrosion resistant metal; the use of "wire wound" type resistors is prohibited for segments of 8 ohms or less. Mount resistors in substantial, ventilated enclosures constructed entirely of non-combustible materials. Provide resistors with terminals fitted in the coolest position in the enclosure.
- g. Reactors: Provide reactors rated for continuous duty operation based upon the motor nameplate amperes. Select reactors for 60 Hz operation and having taps for field adjustment of inductance so as to permit achievement of the optimum acceleration characteristics for the drive. Secure the cores and the coils of the reactors to prevent any permanent change in the relative position of the parts. Ground the core to the case or make electrically accessible, except for toroidal coils and nonmetallic cores such as ferrities.
- h. Limit Switches: Provide upper and lower limit switches which de-energize the hoist motor. Lift limiting and overload limiting devices which use a clutch to stop motion shall not be furnished with the hoist.
- i. Electrification: For runway electrification provide four continuous copper conductors enclosed in a solid plastic cover; no splices of the conductors will be permitted. Provide two sets of current collectors for each conductor. For bridge-to-trolley provide festooned type electrification utilizing flat cables suspended from carriers riding on an I-beam. Suspend pendent pushbutton station from a festooning system similar to that specified for the bridge-to-trolley electrification system. Provide cables in the festooning system so that a minimum of 20 percent of the conductors are spares at the time of crane acceptance. Do not extend the festooned cable loops below the high hook position.
7. Surface Preparation and Painting: Blast clean all portions of the crane to be painted to the requirements of SSPC SP 6. As soon as practical after blasting, but before any evidence of rust, coat all surfaces with a zinc molybdate primer, applied to a minimum dry film thickness of 2.0 mils (0.05 mm) but not exceeding 4.0 mils (0.1 mm). Apply finish coat of high gloss silicone alkyd copolymer enamel, applied to a minimum dry film thickness of 1.5 mils (0.04 mm) but not exceeding 3.0 mils (0.08 mm). Coat faying surfaces of bolted connections with a zinc molybdate primer, but do not apply finish paint. The color of the finish coat shall be brilliant yellow; the load block shall be brilliant yellow with black diagonal striping. Factory paint electrical and mechanical equipment in accordance with the manufacturer's best standard practice (for the specified environment), except that electrical equipment doors, which expose current-carrying electrical conductors when opened, shall be orange.
8. Identification Plates: Furnish and install identification plates. The identification plates shall be of noncorrosive metal with clearly legible permanent lettering giving the manufacturer's name, model number, capacity in both kilogram and pound units printed in different colors, and other essential information or identification.



9. Markings: Markings shall include trolley motion direction arrows on both sides of trolley and hoist rated capacity on both sides of the hoist or hoist load lock. Markings shall be visible from push button station and from the loading point and shall correspond to the push button labeling on the station.
- E. Patented Track: Provide specially designed beam, i.e., patented track beam, constructed from welded steel components. Provide patented track fabricated by a manufacturer regularly engaged in the production of this type of beam. The lower flange (T-rail) of the beam section shall have flat wheel treads; minimum lower flange width of 3.25 inches (81 mm); chemical composition of 0.45 to 0.60 percent carbon content, 0.60 to 1.1 percent manganese content; and wheel treads shall be hardened to a minimum hardness of 225 BHN. The upper flange and web of the beam section shall be structural steel, provided as one monolithic piece rolled to shape or fabricated from two pieces with the flange and web continuously fillet welded on both sides. The joint between the web and the T-rail shall be continuously welded from both sides. Provide shop drawings and calculations for the strength design and deflection of the bridge beams for approval by the the Owner. Size beam, as a minimum, to withstand all expected forces and the load combinations specified herein.
- F. Runway System: Provide flexible suspension type runway system including runway track beams, hanger rods, suspension fittings, lateral and longitudinal sway bracing, various structural supports (as required), and necessary hardware. Provide patented track runway track beams designed and fabricated as specified herein. Deliver patented track square, without excessive warpage, and meeting or exceeding the dimensional requirements of AWS D14.1. Select runway suspension hanger rods fabricated from alloy steel with rolled threads. Provide threads of sufficient length to permit at least 1.0 inch of vertical adjustment (up or down) after runway installation. Provide rods with self-aligning gimbal or ball-and-socket joints at each end which allow at least 5.0 degrees of deflection from the vertical. Provide not more than two rods per suspension point and in such cases consider the unequal loads induced in the rods; fluid-filled load equalizing cells are not acceptable.
- G. High-Strength Bolts, Nuts, And Washers: Provide high-strength bolts and nuts of U.S. manufacture, plain (non-coated), and permanently marked (by embossing or indentation) with the ASTM or SAE designation, grade, and manufacturer's identification. Make structural connection of girder to end truck with ASTM A 325/A 325M plain (non-coated) bolts; appropriate ASTM A 194/A 194M or ASTM A 563/A 563M plain nuts; and ASTM F 436/F 436M plain, through hardened, flat, circular washers. Match bolt and nut threads (oversize tapping is not permitted); bolt and nut threads shall conform to ASME/ANSI B18.2.2 and ASME B1.1. Make mechanical connections with ASTM A 325/A 325M bolts, as described above, or with SAE J 429, Grade 5 bolts and SAE J 995, Grade 5 nuts.
- H. Source Quality Control: Inspect and test bolts according to the "Production Lot Method" described in ASTM A 325/A 325M. Process bolts so that the identity and integrity of each production lot, from raw material selection through all processing operations and treatments to final packing and shipment are maintained. Bolts will not be acceptable unless positive traceability of the bolts is established.

### 1.3 EXECUTION

- A. Erection: Shop assemble crane and crane components to the maximum extent to facilitate erection and minimize field labor. Size each assembly so that it can be transported by common carrier without disassembly insofar as shipping clearances are concerned. Protect parts and equipment delivered to the site from weather, damage, abuse, and loss of identification. Ensure that the crane is erected without initial stresses, forced or improvised fits, misalignments, stress-raising welds, and rough burrs. Solvent-clean wire ropes to remove all preservative and grease-lubricate in accordance with wire rope manufacturer's recommendations prior to reeving. Erect crane within 30 days of the initial delivery of components. After the crane is erected, clean and retouch damaged painted surfaces.
- B. Erection Services: The crane manufacturer shall provide supervisory erection services.

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### C. Field Quality Control

1. Post-Erection Inspection: After erection, the Contractor and the the Owner shall jointly inspect the crane bridge and hoist systems and components to determine compliance with specifications and approved shop drawings and manufacturer's data. The Contractor shall notify the the Owner 3 days before the inspection.
2. Operational Tests: After erection and inspection, test the hoist, bridge, and trolley as specified herein. The 125 percent rated load test shall be made with the bridge and trolley located to obtain maximum loads on the runway and bridge girders. The systems shall be tested in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacture, installation, and workmanship. The Contractor shall rectify all deficiencies disclosed by testing and retest the system or component to prove the crane is operational. The Contractor shall furnish operating personnel, instruments, and all other necessary apparatus. The the Owner will furnish loads and rigging gear to be used for testing.
3. Test Data:
  - a. Record crane test data on appropriate test record forms suitable for retention for the life of the crane. Include in the test records:
    - 1) Test date
    - 2) Crane identification number
    - 3) Weather conditions (temperature, humidity, barometric pressure, dew point, prevailing wind direction and velocity, and crane orientation)
    - 4) Identification of each test performed
    - 5) Results of each test performed
    - 6) Data collected during testing
    - 7) Remarks
  - b. Record operating and startup current and motor terminal voltage measurements for electrical equipment (motors) using appropriate instrumentation (e.g., clamp-on ammeters). Recorded values shall be compared with design specifications or manufacturer's recommended values; abnormal differences (i.e., greater than 10 percent from manufacturer's or design values) shall be justified or appropriate adjustments performed. In addition, high temperatures or abnormal operation of any equipment or machinery shall be noted, investigated, and corrected. Record hoist, trolley, and bridge speeds during each test cycle.
4. Hook: Measure hook for hook throat spread before and after load test. Establish a throat dimension base measurement by installing two tram points and measuring the distance between these tram points (plus or minus 1/64 inch (0.4 mm)). Record this base dimension. Measure the distance between tram points before and after load test. An increase in the throat opening by more than one percent from the base measurement shall be cause for rejection.
5. No-Load Test: Raise and lower the hook through the full range of normal travel at rated speed for three complete cycles. Then raise and lower the hook through the full range of normal travel in slow speed. Verify proper operation of hoist limit switches. Operate the bridge and trolley in each direction the full distance between end stops; bring bumpers into contact with bumper stops at each end of travel. Perform one complete cycle in each speed point and verify proper brake operation.
6. Load Tests
  - a. Hoist: Perform the following tests, as specified, with test loads of 50, 100 and 125 percent (plus 5 minus 0) of rated load.
    - 1) Static Load Test (125 percent only): Check entire structure, holding brake and hoisting components as follows: Raise the test load approximately one foot. Hold the load for 10 minutes. Rotate load and hook to check bearing operation. Observe lowering that may occur which indicates a weakness in the structure or malfunction of hoisting components or brakes
    - 2) Dynamic Load Test (50 percent, 100 percent, and 125 percent): Raise and lower the test load through the full lift in each speed point. Lower the load to the floor, wait



- 5 minutes, then raise and lower the load through two more cycles, one in each speed point. In addition, repeat the dynamic test of test load sequence number 2 (100 percent of rated load) for 10 cycles at rated speed, in order to demonstrate proper operation and repeatability of all functions without component overheating or malfunction. Completely stop the machinery at least once in each direction during each cycle to ensure proper brake operation. Stop the hoist for not more than 15 seconds prior to commencing the next cycle.
- 3) Hoist Load Brake (125 percent only): Raise test load approximately 5 feet (1500 mm). With neither pushbutton depressed, release (by hand) the holding brake. The load brake shall hold the test load. Again with the holding brake in the released position, start the test load down (first point) and then release the pushbutton as the test load lowers. The load brake shall prevent the test load from accelerating.
  - 4) Hoist Loss of Power Test (125 percent only): Raise the test load to approximately 8 feet (2400 mm). While slowly lowering the test load, disconnect the crane's power source. Verify that the test load does not lower and that the brake is set.
- b. Trolley/Hoist: Operate the trolley/hoist the full distance of the bridge rails in each direction with a test load of 125 percent of rated load on the hook (one cycle). Check proper functioning of all drive speed control points. Verify proper brake action.
  - c. Bridge: With a test load of 125 percent of rated load on the hook, operate the bridge for the full length of the runway in one direction with the trolley/hoist at the extreme end of the bridge, and in the opposite direction with the trolley at the opposite extreme end of the bridge (one cycle). Check proper functioning of all drive speed control points. Check for any binding of the bridge end trucks and verify proper brake action. Record deficiencies. Secure from testing if deficiencies are found.
  - d. Rated Travel Tests: Repeat travel tests for trolley/hoist and bridge with a test load of 100 percent of rated load. Repeat the test for 5 cycles (at least one cycle in each speed point) to demonstrate proper operation and repeatability of all functions without the overheating or malfunction of any components. Completely stop the machinery at least once in each direction during each cycle to ensure proper brake action. Stop the machinery for not more than 15 seconds prior to commencing the next cycle.

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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 05 23 00	26 05 13 00	Conductors And Cables
26 05 23 00	26 05 13 00a	Undercarpet Cables
26 05 23 00	26 05 19 16c	Control-Voltage Electrical Power Cables
26 05 23 00	26 05 13 00b	Medium-Voltage Cables



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**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.
  - 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 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



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 05 26 00	01 22 16 00	No Specification Required
26 05 26 00	02 84 33 00	Overhead Electrical Distribution



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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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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
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 05 19 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 13 00	Conductors And Cables
26 05 33 13	26 05 19 16d	Communications Equipment Room Fittings
26 05 33 13	26 05 19 16e	Communications Backbone Cabling
26 05 33 13	26 05 19 16f	Communications Horizontal Cabling
26 05 33 13	26 05 19 16g	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).

END OF SECTION 26 05 33 16a



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 05 33 16	26 05 19 16b	Electrical Renovation
26 05 33 23	26 05 33 16	Raceways And Boxes
26 05 33 23	26 05 19 13	Underfloor Raceways For Electrical Systems



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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 retorqued 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



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 05 39 00	26 05 19 13	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 16d	Communications Equipment Room Fittings
26 05 43 00	26 05 19 16e	Communications Backbone Cabling
26 05 43 00	26 05 19 16f	Communications Horizontal Cabling
26 05 43 00	26 05 19 16g	Conductors and Cables for Electronic Safety and Security
26 05 46 00	02 84 33 00	Overhead Electrical Distribution



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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



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 05 83 00	26 05 13 00	Conductors And Cables
26 05 83 00	26 05 13 00a	Undercarpet Cables
26 05 83 00	26 05 13 00b	Medium-Voltage Cables



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## SECTION 26 09 23 00 - LIGHTING CONTROLS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for lighting controls. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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 manually operated lighting controls with relays, electrically operated circuit breakers, and control module.
2. This Section includes manually operated, PC-based, digital lighting controls with external signal source, relays, electrically operated circuit breakers, and control module.
3. This Section includes individually addressable lighting control devices communicating with data-entry and -retrieval devices using DALI protocol.

#### C. Definitions

1. BACnet: A networking communication protocol that complies with ASHRAE 135.
2. BAS: Building automation system.
3. DALI: Digital addressable lighting interface.
4. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
5. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
6. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
7. PC: Personal computer; sometimes plural as "PCs."
8. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.
9. RS-485: A serial network protocol, similar to RS-232, complying with TIA/EIA-485-A.

#### D. Submittals

1. Product Data: For control modules, power distribution components, DALI network materials, manual switches and plates, and conductors and cables.
2. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.
  - a. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
  - b. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
  - c. Wiring Diagrams: Power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
3. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
  - a. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
  - b. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.



4. Software and Firmware Operational Documentation:
    - a. Software operating and upgrade manuals.
    - b. Program Software Backup: On a magnetic media or compact disc, complete with data files.
    - c. Device address list.
    - d. Printout of software application and graphic screens.
  5. Field quality-control test reports.
  6. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.
  7. Operation and maintenance data.
  8. Warranty: Special warranty specified in this Section.
- E. Quality Assurance
1. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.
  2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
  3. Comply with 47 CFR, Subparts A and B, for Class A digital devices.
  4. Comply with protocol described in IEC 60929, Annex E, for DALI lighting control devices, wiring, and computer hardware and software.
  5. Comply with NFPA 70.
- F. Coordination
1. Coordinate lighting control components to form an integrated interconnection of compatible components. Match components and interconnections for optimum performance of lighting control functions.
    - a. Coordinate lighting controls with BAS **OR** HVAC controls, **as directed**. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
    - b. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.
  2. Coordinate lighting control components specified in this Section with components specified in Division 26 Section "Panelboards".
- G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
    - a. Failures include, but are not limited to, the following:
      - 1) Failure of software input/output to execute switching or dimming commands.
      - 2) Failure of modular relays to operate under manual or software commands.
      - 3) Damage of electronic components due to transient voltage surges.
    - b. Warranty Period: Two years from date of Final Completion.
    - c. Extended Warranty Period Failure Due to Transient Voltage Surges: Eight years.
    - d. Extended Warranty Period for Electrically Held Relays: 10 years from date of Final Completion.
- H. Software Service Agreement (May Not Be Allowed For Publicly Funded Projects)
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 revise licenses for use of the software.



- a. Provide 30-day 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. System Requirements

1. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.
2. Performance Requirements (for programmable system that controls manual and automatic operation that is not PC based): Manual switch operation sends a signal to programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays **OR** electrically operated circuit breakers, **as directed**, in the power-supply circuits to groups of lighting fixtures or other loads.
3. Performance Requirements (for PC-based programmable system that controls manual and automatic operation): Manual switches, an internal timing and control unit, and external sensors or other control signal sources send a signal to a PC-based programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays **OR** electrically operated circuit breakers, **as directed**, in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of lighting fixtures or other loads.
4. Performance Requirements (for DALI-compliant program): Individually addressable devices (such as electronic ballasts, dimmers, and manual switches) are operated from digital signals received through a DALI-compliant bus, from data-entry and -retrieval devices (such as PCs, personal digital assistants (PDAs), hand-held infrared programming devices, wired Ethernet hubs, wireless IEEE 802.11 hubs). Devices also report status to data-entry and -retrieval devices through the bus.
5. BAS Interface: Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports.
  - a. Hardwired Points:
    - 1) Monitoring: On-off status, <Insert monitoring point>.
    - 2) Control: On-off operation, <Insert control point>.
  - b. ASHRAE 135 (BACnet) **OR** LonTalk **OR** Modbus **OR** Industry-accepted, open-protocol, **as directed**, communication interface with the BAS shall enable the BAS operator to remotely control and monitor lighting from a BAS operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the BAS.

### B. Control Module

1. Control Module Description: (This is a generic, nonproprietary control module that is not PC based.) Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Output circuits shall be switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits shall be pilot-duty relays compatible with power switching devices. An integral keypad shall provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use. An integral alphanumeric LCD or LED shall display menu-assisted programming and control.
2. Control Module Description: (These are typical systems developed by time-switch manufacturers as an expansion and refinement of their microprocessor-based, digital, time-switch product lines - controls are not PC based.) Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Unit shall be programmable for control of indicated number of output circuits. Output circuits shall be switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits shall be pilot-duty relays compatible with power switching devices, all located in other enclosures. An integral keypad shall provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use. An integral



- alphanumeric LCD shall display manual-control and programming steps. Modules and their associated control panels shall include the following features:
- a. Multichannel output with <Insert number> channels.  
**OR**  
 Multiple inputs and multichannel output arranged for <Insert number> channels.
  - b. Multiple inputs for indicated occupancy sensors and hand-held programming device.
3. Control Module Description: (These are low-voltage control systems developed by high-end, remote-control dimmer system manufacturers - controls are not PC based.) Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Control units shall be programmable and capable of receiving inputs from indicated sensors and hand-held programmer. Output circuits shall be pilot-duty relays compatible with power switching devices. Output circuits shall include digital circuits arranged to transmit control commands to remote preset dimmers. Modules and their associated control panels shall include the following features:
    - a. Multichannel output with <Insert number> channels.  
**OR**  
 Multiple inputs and multichannel output arranged for <Insert number> channels.
    - b. Multiple inputs for occupancy sensors, daylight sensors, and dimming systems with associated daylight sensors.
  4. Control Module Description: (This is a low-voltage control system developed around panelboards with electrically operated, molded-case circuit breakers and control module installed in panelboard - controls are not PC based.) Panelboard mounted; comply with UL 916 (CSA C22.2, No. 205); microprocessor based, solid-state, 365-day timing and control unit. Control units shall be programmable and capable of receiving inputs from sensors and other sources. Panelboard shall use low-voltage-controlled, electrically operated, molded-case branch circuit breakers as prime power-circuit switching devices. Circuit breakers and a limited number of digital or analog, low-voltage control-circuit outputs shall be individually controlled by control module. Line-voltage components and wiring shall be separated from low-voltage components and wiring by barriers. Control module shall be locally programmable. Panelboard shall also comply with Division 26 Section "Panelboards".
  5. Control Module Description: (This is a refinement of classic low-voltage control system originally developed for manual, multipoint lighting control using latching-type, single-pole relays to switch 120- and 277-V circuits - controls are not PC based.) Comply with UL 508 (CSA C22.2, No. 14); microprocessor-based, programmable, control unit; mounted in preassembled, modular relay panel. Low-voltage-controlled, latching-type, single-pole lighting circuit relays shall be prime output circuit devices. Where indicated, a limited number of digital or analog, low-voltage control-circuit outputs shall be supported by control unit and circuit boards associated with relays. Control units shall be capable of receiving inputs from sensors and other sources. Line-voltage components and wiring shall be separated from low-voltage components and wiring by barriers. Control module shall be locally programmable.
  6. Control Module Description: (This is a typical PC-based software control system developed to operate panelboards with electrically operated circuit breakers, relay boards with latching-type control relays, and individually addressable DALI-compliant devices. This control scheme is also suitable for integrating one or more of these boards to a PC-based control network (such as BAS, detention monitoring and control system, and HVAC control system) specified in another Section.) Programmable, PC-based unit with 17-inch color video monitor **OR** 15-inch color LCD, **as directed**, and keyboard for graphic display and programming of system status and to override breaker status; and to display status of local override controls and diagnostic information. If the control module is applied to emergency lighting units, control unit shall indicate failure of normal power and that the lighting units are, or are not, powered by the alternate power source.
    - a. Display: Single graphic display for programming lighting control panelboards.  
**OR**  
 Display: Separate graphic displays for programming each lighting control panelboard.
    - b. Interoperability: Control module shall be configured to connect with other control systems using RS-485 network to enable remote workstations to use control module functions.

**OR**

Interoperability: Control module shall be configured to connect to LonWorks-compliant **OR** BACnet-compliant, **as directed**, network, resulting in extending control to any network-compliant devices such as occupancy switches.

**OR**

Interoperability: Lighting control shall be configured to allow individual users to turn lighting on and off with their PCs. Software shall be written for Windows operating system, with Web page as the display and ActiveX controls that can be accessed through an Internet browser. Include at least three levels of password protection. Include an egress lighting option that will provide each user with a lighted path for exiting the building after normal working hours.

**OR**

Interoperability: Lighting control shall be configured to allow individual users to turn lighting on and off with DALI-compliant, digital-communication devices. Software shall be written for Windows operating system, with the full suite of DALI commands and device parameter settings.

- c. System Memory: Nonvolatile. System shall reboot program and reset time automatically without errors after power outages up to 90 days' duration.
- d. Software: Lighting control software shall be capable of linking switch inputs to relay outputs, retrieving links, viewing relay output status, controlling relay outputs, simulating switch inputs, setting device addresses, and assigning switch input and relay output modes.
- e. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight saving time and shall provide weekly routine and annual holiday scheduling.
- f. Astronomic Control: Automatic adjustment of dawn and dusk switching.
- g. Demand Control: Demand shall be monitored through pulses from a remote meter and shall be controlled by programmed switching of loads. System capability shall include sliding window averaging and programming of load priorities and characteristics. Minimum of two different time-of-day demand schedules shall execute load-management control actions by switching output circuits or by transmitting other types of load-control signals.
- h. Confirmation: Each relay or contactor device operated by system shall have auxiliary contacts that provide a confirmation signal to the system of on or off status of device. On or off status confirmation for each electrically operated circuit breaker shall be provided by an auxiliary contact or by a sensing device at load terminal.
  - 1) Software shall interpret status signals, provide for their display, and initiate failure signals.

**OR**

Lamp or LED at control module or display panel shall identify status of each controlled circuit.

- i. Remote Communication Capability: Allow programming, data-gathering interrogation, status display, and controlled command override from a PC at a remote location over telephone lines **OR** data links **OR** DALI networks **OR** power line carrier, **as directed**. System shall include modem, communications and control software, and remote computer compatibility verification for this purpose.
- j. Telephone Override Capability: Override programmed lighting shutdown commands by telephoning computer and shall enter a voice-menu-guided, override touch-tone code specific to zone being controlled.
- k. Local Override Capability: Manual, low-voltage control devices shall override programmed shutdown of lighting and shall override other programmed control for intervals that may be duration programmed.
- l. Automatic Control of Local Override: Automatic control shall switch lighting off if lighting has been switched on by local override. Comply with provisions in California Code of Regulations, Title 24, Part 6, **as directed**.
- m. Automatic battery backup shall provide power to maintain program and system clock operation for 90 days' minimum duration when power is off.
- n. Programmed time signals shall change preset scenes and dimmer settings.



- o. Daylight Balancing Dimming Control: Control module shall interpret variable analog signal from photoelectric sensor and shall route dimming signals to dimming fluorescent ballast control circuits. Signal shall control dimming of fixture so illumination level remains constant as daylight contribution varies.
- p. Daylight Compensating Switch Control: Control module shall interpret a preset threshold illumination-level signal from a photoelectric relay and shall activate relays controlling power to selected groups of lighting fixtures to turn them on and off to maintain adjustable minimum illumination level as daylight contribution varies.
- q. Energy Conservation: Bilevel control of special ballasts or dimming circuits to comply with local energy codes.
- r. Flick Warning: Programmable momentary turnoff of lights shall warn that programmed shutoff will occur after a preset interval. Warning shall be repeated after a second preset interval before end of programmed override period.
- s. Diagnostics: When system operates improperly, software shall initiate factory-programmed diagnosis of failure and display messages identifying problem and possible causes.
- t. Additional Programming: In addition to system programming by the PC, individual control modules shall be programmable using data-entry and -retrieval (such as PCs, personal digital assistants (PDAs), hand-held infrared programming devices, wired Ethernet hubs, wireless IEEE 802.11 hubs).

C. Power Distribution Components (For DALI-Compliant Networks)

1. Modular Relay Panel: Comply with UL 508 (CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.
  - a. Cabinet: Steel with hinged, locking door.
    - 1) Barriers separate low-voltage and line-voltage components.
    - 2) Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
    - 3) Control Power Supply: Transformer and full-wave rectifier with filtered dc output.
  - b. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.
    - 1) Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
    - 2) Rated Capacity (Mounted in Relay Panel): 20 A, 125-V ac for tungsten filaments; 20 A, 277-V ac for ballasts.
    - 3) Endurance: 50,000 cycles at rated capacity.
    - 4) Mounting: Provision for easy removal and installation in relay cabinet.
2. Electrically Operated, Molded-Case Circuit-Breaker Panelboard: Comply with NEMA PB 1 and UL 50 (CSA C22.2, No. 94), UL 67 (CSA C22.2, No. 29), UL 489 (CSA C22.2, No. 65), and UL 916 (CSA C22.2, No. 205).
  - a. Cabinets: In addition to requirements specified below, comply with Division 26 Section "Panelboards".
  - b. Electrically Operated, Molded-Case Circuit Breakers: Bolt-on type.
    - 1) Switching Endurance Ratings: Certified by manufacturer or by a nationally recognized testing laboratory (NRTL) for at least 20,000 open and close operations under rated load at 0.8 power factor.
    - 2) Minimum 30,000 open and close operations with load equal to circuit-breaker trip rating and consisting of 100 percent tungsten filament load.
    - 3) Minimum 30,000 open and close operations with load equal to circuit-breaker trip rating and consisting of 100 percent fluorescent ballasts rated for 10 percent total harmonic distortion.
    - 4) Listed and labeled as complying with UL SWD, HCAR, and HID ratings by a national recognized testing laboratory (NRTL) acceptable to authorities having jurisdiction.
3. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels.

**OR**

Line-Voltage Surge Suppression: Field-mounting surge suppressors that comply with Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits" for Category A locations.

**OR**

Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels or field-mounting surge suppressors that comply with Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits" for Category A locations.

**D. DALI Network Materials**

1. Network Power Supply and Router: Interface device connecting TCP/IP control networks to DALI-compliant network.
  - a. DALI-Compliant Network Power Rating: One full-rated network for **OR** Two full-rated networks, each capable of, **as directed**, powering up to 64 addressable devices for each network; suitable for use with NFPA 70, Class 1 and Class 2 control circuits; and 16 V dc, 250 mA.
  - b. Primary Power: 120 or 277 V, field selectable; 12 VA.
  - c. 10basT Ethernet port.
  - d. LED indicator lights for Ethernet status (link, send, and receive), power-on, and DALI network failure.
2. Lighting Control Software:
  - a. Five-tier hierarchical architecture; high-speed, parallel query; and distributed-logic processing scalable from single rooms to full campuses.
  - b. Automatic backup for all settings and parameters.
  - c. TCP/IP network protocol.
  - d. Interactive with other building management systems at TCP/IP level.
  - e. At least three security levels.
  - f. Support the full suite of DALI commands and device parameter settings.
  - g. Scheduling modules to provide building-wide scene scheduling.
  - h. Billing modules to track energy use for multiple tenants and able to produce monthly billing statements.
  - i. Support load shedding, peak shaving, sweeps with local override, and other energy-conservation measures.
  - j. Able to report individual device status, including inoperative lamps, ballast failure detection, and dimmer position.

**E. Manual Switches And Plates**

1. Push-Button Switches: Modular, momentary-contact, low-voltage type.
  - a. Match color specified in Division 26 Section "Wiring Devices".
  - b. Integral green LED **OR** neon, **as directed**, pilot light to indicate when circuit is on.
  - c. Internal white LED **OR** neon, **as directed**, locator light to illuminate when circuit is off.
2. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Division 26 Section "Wiring Devices".
3. Wall-Box Dimmers: Comply with Division 26 Section "Wiring Devices".
4. Wall Plates: Single and multigang plates as specified in Division 26 Section "Wiring Devices"
5. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

**F. Conductors And Cables**

1. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
2. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 **OR** 22 **OR** 24, **as directed**, AWG, complying with Division 26 Section "Low-voltage Electrical Power Conductors And Cables".



3. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 **OR** 16 **OR** 18, **as directed**, AWG, complying with Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
4. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e **OR** 6, **as directed**, for horizontal copper cable and with Division 28 Section "Conductors And Cables For Electronic Safety And Security".

### 1.3 EXECUTION

#### A. Wiring Installation

1. Comply with NECA 1.
2. Wiring Method: Install wiring in raceways except where installed in accessible ceilings and gypsum board partitions. Comply with Division 26 Section "Low-voltage Electrical Power Conductors And Cables". Minimum conduit size shall be 1/2 inch (13 mm).
3. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
4. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
5. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
6. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.
7. Identify components and power and control wiring according to Division 26 Section "Identification For Electrical Systems".

#### B. Field Quality Control

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and assist in field testing. Report results in writing.
2. Perform the following field tests and inspections and prepare test reports:
  - a. Test for circuit continuity.
  - b. Verify that the control module features are operational.
  - c. Check operation of local override controls.
  - d. Test system diagnostics by simulating improper operation of several components selected by the Owner.

#### C. Software Installation

1. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

#### D. Adjusting

1. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting sensors and to assist the Owner's personnel in making program changes to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

#### E. Demonstration

1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain lighting controls and software training for PC-based control systems.

END OF SECTION 26 09 23 00



## SECTION 26 09 23 00a - LIGHTING CONTROL DEVICES

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for lighting control 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 lighting control devices:
  - a. Time switches.
  - b. Outdoor and Indoor photoelectric switches.
  - c. Indoor occupancy sensors.
  - d. Outdoor motion sensors.
  - e. Lighting contactors.
  - f. Emergency shunt relays.

#### C. Definitions

1. LED: Light-emitting diode.
2. PIR: Passive infrared.

#### D. Submittals

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

### 1.2 PRODUCTS

#### A. Time Switches

1. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
  - a. Contact Configuration: SPST **OR** DPST **OR** DPDT, **as directed**.
  - b. Contact Rating: 30-A inductive or resistive, 240-V ac **OR** 20-A ballast load, 120/240-V ac, **as directed**.
  - c. Program: 8 on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays, **as directed**.  
**OR**  
Program: 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays, **as directed**.  
**OR**  
Programs: channels; each channel shall be individually programmable with 8 on-off set points on a 24-hour schedule.  
**OR**  
Programs: channels; each channel shall be individually programmable with 2 on-off set points on a 24-hour schedule with skip-a-day weekly schedule.

**OR**

Programs: channels; each channel shall be individually programmable with 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week.

**OR**

Programs: channels; each channel shall be individually programmable with 40 on-off operations per week and an annual holiday schedule that overrides the weekly operation on holidays.

**OR**

Programs: channels; each channel shall be individually programmable with 40 on-off operations per week, plus 4 seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays.

**OR**

Program: Configuration, as directed by the Owner and an annual holiday schedule that overrides the weekly operation on holidays, **as directed**.

- d. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels, **as directed**.
  - e. Astronomic Time: All **OR** Selected, **as directed**, channels.
  - f. Battery Backup: For schedules and time clock.
2. Electromechanical-Dial Time Switches: Type complying with UL 917.
- a. Contact Configuration: SPST **OR** DPST **OR** SPDT **OR** DPDT, **as directed**.
  - b. Contact Rating: 30-A inductive or resistive, 240-V ac **OR** 20-A ballast load, 120/240-V ac, **as directed**.
  - c. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
  - d. Astronomic time dial.
  - e. Eight-Day Program: Uniquely programmable for each weekday and holidays.
  - f. Skip-a-day mode.
  - g. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

**B. Outdoor Photoelectric Switches**

1. Description: Solid state, with SPST **OR** DPST, **as directed**, dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
  - a. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off, **as directed**.
  - b. Time Delay: 15-second minimum, to prevent false operation.
  - c. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
  - d. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

**OR**

Description: Solid state, with SPST **OR** DPST, **as directed**, dry contacts rated for 1800 VA to operate connected load, relay, or contactor coils; complying with UL 773.

- a. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range.
- b. Time Delay: 30-second minimum, to prevent false operation.
- c. Lightning Arrester: Air-gap type.
- d. Mounting: Twist lock complying with IEEE C136.10, with base.

**C. Indoor Photoelectric Switches**



1. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit mounted on luminaire, **as directed**, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
    - a. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
    - b. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
    - c. Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lx) **OR** 100 to 1000 fc (1080 to 10 800 lx), **as directed**, with an adjustment for turn-on and turn-off levels within that range.
    - d. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
    - e. Indicator: Two LEDs to indicate the beginning of on-off cycles.
  2. Skylight Photoelectric Sensors: Solid-state, light-level sensor; housed in a threaded, plastic fitting for mounting under skylight, facing up at skylight; with separate relay unit mounted on luminaire, **as directed**, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
    - a. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
    - b. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
    - c. Light-Level Monitoring Range: 1000 to 10,000 fc (10 800 to 108 000 lx), with an adjustment for turn-on and turn-off levels within that range.
    - d. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
    - e. Indicator: Two LEDs to indicate the beginning of on-off cycles.
- D. Indoor Occupancy Sensors
1. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
    - a. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
    - b. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
    - c. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
    - d. Mounting:
      - 1) Sensor: Suitable for mounting in any position on a standard outlet box.
      - 2) Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
      - 3) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
    - e. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
    - f. Bypass Switch: Override the on function in case of sensor failure.
    - g. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); keep lighting off when selected lighting level is present.
  2. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
    - a. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
    - b. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.



- c. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.
  3. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
    - a. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
    - b. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
    - c. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
    - d. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
    - e. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).
  4. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
    - a. Sensitivity Adjustment: Separate for each sensing technology.
    - b. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
    - c. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
- E. Outdoor Motion Sensors (PIR)
  1. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F (minus 40 to plus 54 deg C), rated as raintight according to UL 773A.
    - a. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
    - b. Mounting:
      - 1) Sensor: Suitable for mounting in any position on a standard outdoor junction box.
      - 2) Relay: Internally mounted in a standard weatherproof electrical enclosure.
      - 3) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
    - c. Bypass Switch: Override the on function in case of sensor failure.
    - d. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc (11 to 215 lx); keep lighting off during daylight hours.
  2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
  3. Detection Coverage: Up to 35 feet (11 m), with a field of view of 90 degrees **OR** Up to 100 feet (30 m), with a field of view of 60 degrees **OR** Up to 35 feet (11 m), with a field of view of 180 degrees **OR** Up to 52.5 feet (16 m), with a field of view of 270 degrees, **as directed**.
  4. Lighting Fixture Mounted Sensor: Suitable for switching 300 W of tungsten load at 120- or 277-V ac.
  5. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
    - a. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.



- b. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

#### F. Lighting Contactors

1. Description: Electrically operated and mechanically **OR** electrically, **as directed**, held, combination type with fusible switch **OR** nonfused disconnect, **as directed**, complying with NEMA ICS 2 and UL 508.
  - a. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
  - b. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
  - c. Enclosure: Comply with NEMA 250.
  - d. Provide with control and pilot devices as indicated on Drawings **OR** scheduled, **as directed**, matching the NEMA type specified for the enclosure.
2. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
  - a. Monitoring: On-off status, as directed by the Owner.
  - b. Control: On-off operation, as directed by the Owner.

#### G. Emergency Shunt Relay

1. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic, **as directed**, switching contacts; complying with UL 924.
  - a. Coil Rating: 120 **OR** 277, **as directed**, V.

#### H. Conductors And Cables

1. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
2. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 **OR** 22 **OR** 24, **as directed**, AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
3. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 **OR** 16 **OR** 18, **as directed**, AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

### 1.3 EXECUTION

#### A. Sensor Installation

1. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

#### B. Contactor Installation

1. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

#### C. Wiring Installation

1. Wiring Method: Comply with Division 26 Section "Low-voltage Electrical Power Conductors And Cables". Minimum conduit size shall be 1/2 inch (13 mm).
2. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
3. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.



4. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

D. Identification

1. Identify components and power and control wiring according to Division 26 Section "Identification For Electrical Systems".
  - a. Identify controlled circuits in lighting contactors.
  - b. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
2. Label time switches and contactors with a unique designation.

E. Field Quality Control

1. Perform the following field tests and inspections and prepare test reports:
  - a. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
  - b. Operational Test: Verify operation of each lighting control device, and adjust time delays.
2. Lighting control devices that fail tests and inspections are defective work.

END OF SECTION 26 09 23 00a

**SECTION 26 09 23 00b - ELECTRICAL POWER MONITORING AND CONTROL**

## 1.1 GENERAL

## A. Description Of Work

1. This specification covers the furnishing and installation of materials for electrical power monitoring and 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. This Section includes the following for monitoring and control of electrical power system:
  - a. PC-based workstation(s) and software.
  - b. Communication network and interface modules for RS-232; RS-485, Modbus TCP/IP; and IEEE 802.3 data transmission protocols.

## C. Definitions

1. Ethernet: Local area network based on IEEE 802.3 standards.
2. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.
3. HTML: Hypertext markup language.
4. I/O: Input/output.
5. KB: Short for kilobyte. When used to describe data storage, "KB" represents 1024 bytes.
6. KY Pulse: A term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay changing status in response to the rotation of the disk in the meter.
7. LAN: Local area network; sometimes plural as "LANs."
8. LCD: Liquid crystal display.
9. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.
10. Modbus TCP/IP: An open protocol for exchange of process data.
11. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
12. PC: Personal computer; sometimes plural as "PCs."
13. rms: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
14. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.
15. RS-485: A TIA standard for multipoint communications using two twisted-pairs.
16. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
17. THD: Total harmonic distortion.
18. UPS: Uninterruptible power supply; used both in singular and plural context.
19. WAN: Wide area network.

## D. Submittals

1. Product Data: For each type of product indicated.
  - a. Attach copies of approved Product Data submittals for products (such as switchboards and switchgear) that describe power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.
2. Shop Drawings: For power monitoring and control equipment. Include plans, elevations, sections, details, and attachments to other work.
  - a. Outline Drawings: Indicate arrangement of components and clearance and access requirements.



- b. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
  - c. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - d. Wiring Diagrams: Power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
  - e. UPS sizing calculations for workstation.
  3. Software and Firmware Operational Documentation:
    - a. Self-study guide describing the process for setting equipment's network address; setting the Owner's options; procedures to ensure data access from any PC on the network, using a standard Web browser; and recommended firewall setup.
    - b. Software operating and upgrade manuals.
    - c. Software Backup: On a magnetic media or compact disc, complete with the Owner-selected options.
    - d. Device address list and the set point of each device and operator option, as set in applications software.
    - e. Graphic file and printout of graphic screens and related icons, with legend.
  4. Software Upgrade Kit: For the Owner to use in modifying software to suit future power system revisions or power monitoring and control revisions.
  5. Software licenses and upgrades required by and installed for operating and programming digital and analog devices.
  6. Field quality-control test reports.
  7. Operation and Maintenance Data: For power monitoring and control units, to include in emergency, operation, and maintenance manuals. Include the following:
    - a. Operating and applications software documentation.
    - b. Software licenses.
    - c. Software service agreement.
    - d. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.
    - e. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.
  8. Other Informational Submittals:
    - a. System installation and setup guides, with data forms to plan and record options and setup decisions.
- E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. 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 the operating systems. Upgrade shall include new or revised licenses for use of software.
    - a. Provide 30-day 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. Functional Description

1. Instrumentation and Recording Devices: Monitor and record load profiles and chart energy consumption patterns.
  - a. Calculate and Record the Following:
    - 1) Load factor.
    - 2) Peak demand periods.
    - 3) Consumption correlated with facility activities.
  - b. Measure and Record Metering Data for the Following:
    - 1) Electricity.
    - 2) Domestic water.
    - 3) Natural gas.
2. Software: Calculate allocation of utility costs.
  - a. Automatically Import Energy Usage Records to Allocate Energy Costs for the Following:
    - 1) At least 15 departments.
    - 2) At least 30 tenants.
    - 3) At least five processes.
    - 4) At least five buildings.
  - b. Verify utility bills and analyze alternate energy rates, **as directed**.
3. Power Quality Monitoring: Identify power system anomalies and measure, display, and record trends and alarms of the following power quality parameters:
  - a. Voltage regulation and unbalance.
  - b. Continuous three-phase rms voltage.
  - c. Periodic max./min./avg. samples.
  - d. Harmonics.
  - e. Voltage excursions.
4. Emergency Load Shedding. Preserve critical loads or avoid total shutdown due to unforeseen loss of power sources according to the following logic:
  - a. Determine system topology.
  - b. Evaluate remaining loads and sources.
  - c. Shed loads in less than 100 ms.
5. Demand Management:
  - a. Peaking or co-generator control.
  - b. Load interlocking.
  - c. Load shedding.
  - d. Load trimming.
6. System: Report equipment status and power system control.

### B. System Requirements

1. Monitoring and Control System: Include PC-based workstation **OR** multiple PC-based workstations **OR** multiple PC-based workstations with graphics capability and Web access, **as directed**, with its operating system and application software, connected to data transmission network.
2. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.
  - 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 as recommended by manufacturer for type of line being protected.
3. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.



4. BAS Interface: Provide factory-installed hardware and software to enable the BAS to monitor, display, and record data for use in processing reports.
  - a. Hardwired Monitoring Points: Electrical power demand (kilowatts), electrical power consumption (kilowatt-hours), power factor, **as directed**.  
**OR**  
 ASHRAE 135 (BACnet) **OR** LonTalk **OR** Modbus **OR** Industry-accepted, open-protocol, **as directed**, communication interface with the BAS shall enable the BAS operator to remotely monitor meter information from a BAS operator workstation. Control features and monitoring points displayed locally at metering panel shall be available through the BAS.

#### C. Operating System

1. Software: Configured to run on a portable laptop computer, a single PC, or a palm computer, with capability for accessing a single meter at a time. System is not connected to a LAN. Modbus TCP/IP, RS-232, and RS-485 digital communications.  
**OR**  
 Software: Configured to run on a single PC, with capability for accessing multiple devices simultaneously. Modbus TCP/IP, RS-232, and RS-485 digital communications.  
**OR**  
 Software: Configured for a server and multiple client PCs, each with capability for accessing multiple devices simultaneously. Ethernet, Modbus TCP/IP, RS-232, and RS-485 digital communications.  
**OR**  
 Software: Configured for a server and multiple client PCs, each with capability for accessing multiple devices simultaneously. Software shall include interactive graphics client and shall be Web enabled. Workstations and portable computers shall not require any software except for an Internet browser to provide connectivity and full functionality. Include a firewall recommended by manufacturer. 100 Base-T Ethernet, Modbus TCP/IP RS-232, and RS-485 digital communications.
2. Operating System Software: Based on 32-bit, Microsoft Windows workstation operating system. Software shall have the following features:
  - a. Multiuser and multitasking to allow independent activities and monitoring to occur simultaneously at different workstations.
  - b. Graphical user interface to show pull-down menus and a menu tree format.
  - c. Capability for future additions within the indicated system size limits.
3. Peer Computer Control Software: Shall detect a failure of workstation and associated server, **as directed**, and shall cause other workstation and associated server, **as directed**, to assume control of all system functions without interruption of operation. Drivers shall be provided in both central computers to support this mode of operation.

#### D. Applications Software

1. Basic Requirements:
  - a. Fully compatible with and based on the approved operating system.
  - b. Password-protected operator login and access; three levels, minimum.
  - c. Password-protected setup functions.
  - d. Context sensitive on-line help.
  - e. Capability of creating, deleting, and copying files; and automatically maintaining a directory of all files, including size and location of each sequential and random-ordered record.
  - f. Capability for importing custom icons into graphic views to represent alarms and I/O devices.
  - g. Automatic and encrypted backups for database and history; automatically stored at central control PC **OR** selected workstation, **as directed**, and encrypted with a nine-character alphanumeric password, which must be used to restore or read data contained in backup.
  - h. Operator audit trail for recording and reporting all changes made to user-defined system options.
2. Workstation Server Functions:



- a. Support other client PCs on the LAN and WAN, **as directed**.
- b. Maintain recorded data in databases accessible from other PCs on the LAN and WAN, **as directed**.
3. Data Formats:
  - a. User-programmable export and import of data to and from commonly used Microsoft Windows spreadsheet, database, billing, and other applications; using dynamic data exchange technology.
  - b. Option to convert reports and graphics to HTML format.
  - c. Interactive graphics.
  - d. Option to send preprogrammed or operator designed e-mail reports.
4. Metered Data: Display metered values in real time.
5. Remote Control:
  - a. Display circuit-breaker status and allow breaker control.
  - b. User defined with load-shedding automatically initiated and executed schemes responding to programmed time schedules, set points of metered demands, utility contracted load shedding, or combinations of these.
6. Equipment Documentation: Database for recording of equipment ratings and characteristics; with capability for graphic display on monitors.
7. Graphics: Interactive color-graphics platform with pull-down menus and mouse-driven generation of power system graphics, in formats widely used for such drafting; to include the following:
  - a. Site plan.
  - b. Floor plans.
  - c. Equipment elevations.
  - d. Single-line diagrams.
8. User-Defined Monitoring and Control Events: Display and record with date and time stamps accurate to 0.1 second, and including the following:
  - a. Operator log on/off.
  - b. Attempted operator log on/off.
  - c. All alarms.
  - d. Equipment operation counters.
  - e. Out-of-limit, pickup, trip, and no-response events.
9. Trending Reports: Display data acquired in real-time from different meters or devices, in historical format over user-defined time; unlimited as to interval, duration, or quantity of trends.
  - a. Spreadsheet functions of sum, delta, percent, average, mean, standard deviation, and related functions applied to recorded data.
  - b. Charting, statistical, and display functions of standard Windows-based spreadsheet.
10. Alarms: Display and record alarm messages from discrete input and controls outputs, according to user programmable protocol.
  - a. Functions requiring user acknowledgment shall run in background during computer use for other applications and override other presentations when they occur.
11. Waveform Data: Display and record waveforms on demand or automatically on an alarm or programmed event; include the graphic displays of the following, based on user-specified criteria:
  - a. Phase voltages, phase currents, and residual current.
  - b. Overlay of three-phase currents, and overlay each phase voltage and current.
  - c. Waveforms ranging in length from 2 cycles to 5 minutes.
  - d. Disturbance and steady-state waveforms up to 512 points per cycle.
  - e. Transient waveforms up to 83,333 points per cycle on 60-Hz base.
  - f. Calculated waveform on a minimum of four cycles of data of the following:
    - 1) THD.
    - 2) rms magnitudes.
    - 3) Peak values.
    - 4) Crest factors.
    - 5) Magnitude of individual harmonics.
12. Data Sharing: Allow export of recorded displays and tabular data to third-party applications software.
13. Tenant or Activity Billing Software:



- a. Automatically compute and prepare tenant bills **OR** activity demand and energy-use statements, **as directed**, based on metering of energy use and peak demand integrated over user-defined interval.
  - b. Intervals shall be same as used by electric utilities, including current vendor.
  - c. Import metered data from saved records that were generated by metering and monitoring software.
  - d. Maintain separate directory for each tenant's historical billing information.
  - e. Prepare summary reports in user-defined formats and time intervals.
14. Reporting: User commands initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
- a. Print a record of user-defined alarm, supervisory, and trouble events on workstation printer.
  - b. Sort and report by device name and by function.
  - c. Report type of signal (alarm, supervisory, or trouble), description, date, and time of occurrence.
  - d. Differentiate alarm signals from other indications.
  - e. When system is reset, report reset event with same information concerning device, location, date, and time.
- E. Communication Components And Networks
1. Transient Voltage Surge Suppression and Electromagnetic-Interference Immunity: Include in solid-state equipment. Comply with IEEE C37.90.
  2. Network Configuration: High-speed, multi-access, open nonproprietary, industry standard communication protocol; LANs complying with EIA 485, 100 Base-T Ethernet, and Modbus TCP/IP.
- F. Power Monitors
1. Separately mounted, permanently installed instrument for power monitoring and control.
    - a. Enclosure: NEMA 250, Type 1 **OR** 12, **as directed**.
  2. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
    - a. Indoor installation in non-air-conditioned **OR** nontemperature-controlled, **as directed**, spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
  3. rms Real-Time Measurements:
    - a. Current: Each phase, neutral, average of three phases, percent unbalance.
    - b. Voltage: Line-to-line each phase, line-to-line average of three phases, line-to-neutral each phase, line-to-neutral average of three phases, line-to-neutral percent unbalance.
    - c. Power: Per phase and three-phase total.
    - d. Reactive Power: Per phase and three-phase total.
    - e. Apparent Power: Per phase and three-phase total.
    - f. Power Factor: Per phase and three-phase total.
    - g. Displacement Power Factor: Per phase and three-phase total.
    - h. Frequency.
    - i. THD: Current and voltage.
    - j. Accumulated Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
    - k. Incremental Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
    - l. Conditional Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
  4. Demand Current Calculations, per Phase, Three-Phase Average and Neutral:
    - a. Present.
    - b. Running average.
    - c. Last completed interval.
    - d. Peak.
  5. Demand Real Power Calculations, Three-Phase Total:



- a. Present.
- b. Running average.
- c. Last completed interval.
- d. Predicted.
- e. Peak.
- f. Coincident with peak kVA demand.
- g. Coincident with kVAR demand.
6. Demand Reactive Power Calculations, Three-Phase Total:
  - a. Present.
  - b. Running average.
  - c. Last completed interval.
  - d. Predicted.
  - e. Peak.
  - f. Coincident with peak kVA demand.
  - g. Coincident with kVAR demand.
7. Demand Apparent Power Calculations, Three-Phase Total:
  - a. Present.
  - b. Running average.
  - c. Last completed interval.
  - d. Predicted.
  - e. Peak.
  - f. Coincident with peak kVA demand.
  - g. Coincident with kVAR demand.
8. Average Power Factor Calculations, Demand Coincident, Three-Phase Total:
  - a. Last completed interval.
  - b. Coincident with kW peak.
  - c. Coincident with kVAR peak.
  - d. Coincident with kVA peak.
9. Power Analysis Values:
  - a. THD, Voltage and Current: Per phase, three phase, and neutral.
  - b. Displacement Power Factor: Per phase, three phase.
  - c. Fundamental Voltage, Magnitude and Angle: Per phase.
  - d. Fundamental Currents, Magnitude and Angle: Per phase.
  - e. Fundamental Real Power: Per phase, three phase.
  - f. Fundamental Reactive Power: Per phase.
  - g. Harmonic Power: Per phase, three phase.
  - h. Phase rotation.
  - i. Unbalance: Current and voltage.
  - j. Harmonic Magnitudes and Angles for Current and Voltages: Per phase, up to 31st **OR** 63<sup>rd</sup>, **as directed**, harmonic.
10. Power Demand Calculations: According to one of the following calculation methods, selectable by the user:
  - a. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
  - b. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
    - 1) Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
    - 2) Fixed block that calculates demand at end of the interval.
    - 3) Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.
  - c. Demand Calculation Initiated by a Synchronization Signal:
    - 1) Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.



- 2) Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
  - 3) Demand can be synchronized with clock in the power meter.
11. Sampling:
    - a. Current and voltage shall be digitally sampled at a rate high enough to provide accuracy to 63rd harmonic of 60-Hz fundamental.
    - b. Power monitor shall provide continuous sampling at a rate of 128 samples per cycle on all voltage and current channels in the meter.
  12. Minimum and Maximum Values: Record monthly minimum and maximum values, including date and time of record. For three-phase measurements, identify phase of recorded value. Record the following parameters:
    - a. Line-to-line voltage.
    - b. Line-to-neutral voltage.
    - c. Current per phase.
    - d. Line-to-line voltage unbalance.
    - e. Line-to-neutral voltage unbalance.
    - f. Power factor.
    - g. Displacement power factor.
    - h. Total power.
    - i. Total reactive power.
    - j. Total apparent power.
    - k. THD voltage L-L.
    - l. THD voltage L-N.
    - m. THD current.
    - n. Frequency.
  13. Harmonic Calculation: Display and record the following:
    - a. Harmonic magnitudes and angles for each phase voltage and current through 31<sup>st</sup> **OR** 63<sup>rd</sup>, **as directed**, harmonic. Calculate for all three phases, current and voltage, and residual current. Current and voltage information for all phases shall be obtained simultaneously from same cycle.
    - b. Harmonic magnitude reported as a percentage of the fundamental or as a percentage of rms values, as selected by user.
  14. Current and Voltage Ratings:
    - a. Designed for use with current inputs from standard instrument current transformers with 5-A secondary and shall have a metering range of 0-10 A.
    - b. Withstand ratings shall be not less than 15 A, continuous; 50 A, lasting over 10 seconds, no more frequently than once per hour; 500 A, lasting 1 second, no more frequently than once per hour.
    - c. Designed for use with voltage inputs from standard instrument potential transformers with a 120-V secondary.
  15. Accuracy:
    - a. Comply with ANSI C12.20, Class 0.5; and IEC 60687, Class 0.5 for revenue meters.
    - b. Accuracy from Light to Full Rating:
      - 1) Power: Accurate to 0.25 percent of reading, plus 0.025 percent of full scale.
      - 2) Voltage and Current: Accurate to 0.075 percent of reading, plus 0.025 percent of full scale.
      - 3) Power Factor: Plus or minus 0.002, from 0.5 leading to 0.5 lagging.
      - 4) Frequency: Plus or minus 0.01 Hz at 45 to 67 Hz.
  16. Waveform Capture:
    - a. Capture and store steady-state waveforms of voltage and current channels; initiated manually. Each capture shall be for 3 cycles, 128 data points for each cycle, allowing resolution of harmonics to 31st harmonic of basic 60 Hz.
    - b. Store captured waveforms in internal nonvolatile memory; available for PC display, archiving, and analysis.
  17. Input: One digital input signal(s).



- a. Normal mode for on/off signal.
  - b. Demand interval synchronization pulse, accepting a demand synchronization pulse from a utility demand meter.
  - c. Conditional energy signal to control conditional energy accumulation.
18. Outputs:
- a. Operated either by user command sent via communication link, or set to operate in response to user-defined alarm or event.
  - b. Closed in either a momentary or latched mode as defined by user.
  - c. Each output relay used in a momentary contact mode shall have an independent timer that can be set by user.
  - d. One digital KY pulse to a user-definable increment of energy measurement. Output ratings shall be up to 120-V ac, 300-V dc, 50 mA, and provide 3500-V rms isolation.
  - e. One relay output module(s), providing a load voltage range from 20- to 240-V ac or from 20- to 30-V dc, supporting a load current of 2 A.
  - f. Output Relay Control:
    - 1) Relay outputs shall operate either by user command sent via communication link or in response to user-defined alarm or event.
    - 2) Normally open and normally closed contacts, field configured to operate as follows:
      - a) Normal contact closure where contacts change state for as long as signal exists.
      - b) Latched mode when contacts change state on receipts of a pickup signal; changed state is held until a dropout signal is received.
      - c) Timed mode when contacts change state on receipt of a pickup signal; changed state is held for a preprogrammed duration.
      - d) End of power demand interval when relay operates as synchronization pulse for other devices.
      - e) Energy Pulse Output: Relay pulses quantities used for absolute kWh, absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
      - f) Output controlled by multiple alarms using Boolean-type logic.
19. Onboard Data Logging:
- a. Store logged data, alarms, events, and waveforms in 80 **OR** 800, **as directed**, KB of onboard nonvolatile memory.
  - b. Stored Data:
    - 1) Billing Log: User configurable; data shall be recorded every 15 minutes, identified by month, day, and 15-minute interval. Accumulate 24 months of monthly data, 32 days of daily data, and between 2 to 52 days of 15-minute interval data, depending on number of quantities selected.
    - 2) Custom Data Logs: One **OR** Three, **as directed**, user-defined log(s) holding up to 96 parameters. Date and time stamp each entry to the second and include the following user definitions:
      - a) Schedule interval.
      - b) Event definition.
      - c) Configured as "fill-and-hold" or "circular, first-in first-out."
    - 3) Alarm Log: Include time, date, event information, and coincident information for each defined alarm or event.
    - 4) Waveform Log: Store captured waveforms configured as "fill-and-hold" or "circular, first-in first-out."
  - c. Default values for all logs shall be initially set at factory, with logging to begin on device power up.
20. Alarms.
- a. User Options:
    - 1) Define pickup, dropout, and delay.
    - 2) Assign one of four severity levels to make it easier for user to respond to the most important events first.
    - 3) Allow for combining up to four alarms using Boolean-type logic statements for outputting a single alarm.



- b. Alarm Events:
  - 1) Over/undercurrent.
  - 2) Over/undervoltage.
  - 3) Current imbalance.
  - 4) Phase loss, current.
  - 5) Phase loss, voltage.
  - 6) Voltage imbalance.
  - 7) Over kW demand.
  - 8) Phase reversal.
  - 9) Digital input off/on.
  - 10) End of incremental energy interval.
  - 11) End of demand interval.
- 21. Control Power: 90- to 457-V ac or 100- to 300-V dc.
- 22. Communications:
  - a. Power monitor shall be permanently connected to communicate via Modbus TCP via a 100 Base-T Ethernet **OR** RS-485 Modbus TCP/IP, **as directed**.
  - b. Local plug-in connections shall be for RS-232 and 100 Base-T Ethernet.
- 23. Display Monitor:
  - a. Backlighted LCD to display metered data with touch-screen **OR** touch-pad, **as directed**, selecting device.
  - b. Touch-screen display shall be a minimum 12-inch diagonal, resolution of 800 by 600 RGB pixels, 256 colors; NEMA 250, Type 1 display enclosure.
  - c. Display four values on one screen at same time.
    - 1) Current, per phase rms, three-phase average and neutral, **as directed**.
    - 2) Voltage, phase to phase, phase to neutral, and three-phase averages of phase to phase and phase to neutral.
    - 3) Real power, per phase and three-phase total.
    - 4) Reactive power, per phase and three-phase total.
    - 5) Apparent power, per phase and three-phase total.
    - 6) Power factor, per phase and three-phase total.
    - 7) Frequency.
    - 8) Demand current, per phase and three-phase average.
    - 9) Demand real power, three-phase total.
    - 10) Demand apparent power, three-phase total.
    - 11) Accumulated energy (MWh and MVARh).
    - 12) THD, current and voltage, per phase.
  - d. Reset: Allow reset of the following parameters at the display:
    - 1) Peak demand current.
    - 2) Peak demand power (kW) and peak demand apparent power (kVA).
    - 3) Energy (MWh) and reactive energy (MVARh).
- G. Standalone, Web-Enabled Monitoring And Control Instrument
  - 1. Separately mounted, permanently installed instrument for power monitoring and control.
    - a. Enclosure: NEMA 250, Type 1 **OR** 12, **as directed**.
  - 2. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability.
    - a. Indoor installation in non-air-conditioned **OR** nontemperature-controlled, **as directed**, spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
  - 3. Power-Distribution Equipment Monitor: Web enabled, with integral network port and embedded Web server with factory-configured firmware and HTML-formatted Web pages for viewing of power monitoring and equipment status information from connected devices equipped with digital communication ports.



4. LAN Connectivity: Multipoint, RS-485 Modbus serial communication network, interconnecting all breaker trip units, protective relays, drives, and metering devices equipped with communications. Serial communication network connected to Ethernet server that functions as a gateway and server, providing data access via 10 Base-T **OR** 100 Base-T **OR** 100 Base-FX, **as directed**, LAN.
5. Communication Devices within the Equipment: Addressed at factory and tested to verify reliable communication with network server.
6. Server Configuration:
  - a. Initial network parameters set using a standard Web browser. Connect via a local operator interface, or an RJ-45 port accessible from front of equipment.
  - b. Network server shall be factory programmed with embedded HTML-formatted Web pages that are user configurable and that provide detailed communication diagnostic information for serial and Ethernet ports as status of RS-485 network; with internal memory management information pages for viewing using a standard Web browser.
  - c. Login: Password protected; password administration accessible from the LAN using a standard Web browser.
  - d. Operating Software: Suitable for local access; firewall protected.
7. Data Access:
  - a. Network server shall include embedded HTML pages providing real-time information from devices connected to RS-485 network ports via a standard Web browser.
8. Equipment Monitoring Options: Login shall be followed by a main menu for selecting summary Web pages that follow.
9. Summary Web pages shall be factory configured to display the following information for each communicating device within the power equipment lineup:
  - a. User-Configured Custom Home Page: Provide for the lineup, showing status-at-a-glance of key operating values, **as directed**.
  - b. Circuit Summary Page: Circuit name, three-phase average rms current, power (kW), power factor, and breaker status.
  - c. Load Current Summary Page: Circuit name, Phase A, B, and C rms current values.
  - d. Demand Current Summary Page: Circuit name, Phase A, B, and C average demand current values.
  - e. Power Summary Page: Circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
  - f. Energy Summary Page: Circuit name, energy (kWh), reactive energy (kVARh), and time/date of last reset.
  - g. Transformer Status Page: Transformer tag, coil temperatures, and cooling fan status.
  - h. Motor-Control Center Status Page: Circuit name, three-phase average rms current, thermal capacity (percentage), and drive output frequency (Hz) contactor status.
  - i. Specific Device Pages: Each individual communicating device shall display detailed, real-time information, as appropriate for device type.
    - 1) Display historical energy data that shall be logged automatically for each device, as appropriate for device type.
    - 2) Display historical data logged from each device in graphical time-trend plots. Value to be displayed on time-trend plot shall be user selectable. Time interval to be displayed on scale shall be for previous day or week.
  - j. Export historical energy data to a PC or workstation through network using FTP (File Transfer Protocol). Format exported data in a CSV (Comma Separated Variable) file format for importing into spreadsheet applications.
10. Communications:
  - a. Power monitor: Permanently connected to communicate via RS-485 Modbus TCP/IP **OR** Modbus TCP via an 100 Base-T Ethernet, **as directed**.
  - b. Local Plug-in Connections: RS-232 and 100 Base-T Ethernet.
  - c. Monitor Display: Backlighted LCD to display metered data with touch-screen **OR** touch-pad, **as directed**, selecting device.

#### H. Workstation Hardware



1. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
  - a. Indoor installation in spaces that have environmental controls to maintain ambient conditions of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
2. Computer: Standard unmodified PC of modular design. CPU word size shall be 32 bytes or larger; CPU operating speed shall be at least 66 MHz **OR** GHz, **as directed**.
  - a. Memory: 256 MB of usable installed memory, expandable to a minimum of 1024 MB without additional chassis or power supplies.
  - b. Real-Time Clock:
    - 1) Accuracy: Plus or minus 1 minute per month.
    - 2) Time Keeping Format: 24-hour time format including seconds, minutes, hours, date, day, and month; automatic reset by software.
    - 3) Clock shall function for one year without power.
    - 4) Provide automatic time correction once every 24 hours by synchronizing clock with the Time Service Department of the U.S. Naval Observatory.
  - c. Serial Ports: Two RS-232-F serial ports for general use, with additional ports as required. Data transmission rates shall be selectable under program control.
  - d. Parallel Port: Enhanced.
  - e. LAN Adapter Card: 10/100-Mbps PCI bus, internal network interface card.
  - f. Sound Card: For playback and recording of digital WAV sound files associated with audible warning and alarm functions.
  - g. Color Monitor: PC compatible, not less than 18 inches (455 mm), LCD type, with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 mm.
  - h. Keyboard: Minimum of 64 characters, standard ASCII character set based on ANSI INCITS 154.
  - i. Mouse: Standard, compatible with installed software.
  - j. Disk Storage: Include the following, each with appropriate controller:
    - 1) Minimum 80-GB hard disk, maximum average access time of 10 ms.
    - 2) Floppy Disk Drive: High density, 3-1/2-inch (90-mm) size.
    - 3) PCMCIA slot with removable 500-MB media.
    - 4) 100-MB Iomega Zip drive.
    - 5) 250-MB Iomega Jaz drive.
  - k. Magnetic Tape System, **as directed**: 4-mm cartridge magnetic tape system with minimum 2 **OR** 4 **OR** 20, **as directed**, -GB formatted capacity per tape. Provide 10 tapes, each in a rigid cartridge with spring-loaded cover and operator-selectable write-protect feature.
  - l. Modem: 56,600 bps, full duplex for asynchronous communications. With error detection, auto answer/autodial, and call-in-progress detection. Modem shall comply with requirements in ITU-T v.34, ITU-T v.42, ITU-T v.42 Appendix VI for error correction, and ITU-T v.42 BIS for data compression standards; and shall be suitable for operating on unconditioned voice-grade telephone lines complying with 47 CFR 68.
  - m. Audible Alarm: Manufacturer's standard.
  - n. CD-ROM Drive:
    - 1) Nominal Storage Capacity: 650 MB.
    - 2) Data Transfer Rate: 1.2 Mbps.
    - 3) Average Access Time: 150 ms.
    - 4) Cache Memory: 256 KB.
    - 5) Data Throughput: 1 MB/second, minimum.
  - o. Report Printer: Minimum resolution 600 dpi laser printer.
    - 1) Connected to central station and designated workstations.
    - 2) RAM: 2 MB, minimum.
    - 3) Printing Speed: Minimum 12 pages per minute.



- 4) Paper Handling: Automatic sheet feeder with 250-sheet paper cassette and with automatic feed.
  - p. Interface: Bidirectional parallel and universal serial bus.
  - q. LAN Adapter Card: 10/100-Mbps internal network interface card.
  3. Redundant Central Computer: Connected in a hot standby, peer configuration; automatically maintains copies of system software, application software, and data files. System transactions and other activities that alter system data files shall be updated to system files of redundant computer in near real-time. If central computer fails, redundant computer shall assume control immediately and automatically.
  4. UPS: Self-contained; complying with requirements in Division 26 Section "Static Uninterruptible Power Supply".
    - a. Size: Provide a minimum of 6 hours of operation of workstation station equipment, including 2 hours of alarm printer operation, **as directed**.
    - b. Batteries: Sealed, valve regulated, recombinant, lead calcium.
    - c. Accessories:
      - 1) Transient voltage suppression.
      - 2) Input-harmonics reduction.
      - 3) Rectifier/charger.
      - 4) Battery disconnect device.
      - 5) Static bypass transfer switch.
      - 6) Internal maintenance bypass/isolation switch.
      - 7) External maintenance bypass/isolation switch.
      - 8) Output isolation transformer.
      - 9) Remote UPS monitoring.
      - 10) Battery monitoring.
      - 11) Remote battery monitoring.
- I. RS-232 ASCII Interface
1. ASCII interface shall allow RS-232 connections to be made between a meter or circuit monitor operating as the host PC and any equipment that will accept RS-232 ASCII command strings, such as local display panels **OR** dial-up modems **OR** alarm transmitters, **as directed**.
  2. Pager System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.
    - a. RS-232 output shall be capable of connection to a pager interface that can be used to call a paging system or service and send a signal to a portable pager. System shall allow an individual alphanumeric message per alarm input to be sent to paging system. This interface shall support both numeric and alphanumeric pagers.
  3. Alarm System Interface:
    - a. RS-232 output shall be capable of transmitting alarms from other monitoring and alarm systems to workstation software.
  4. Cables:
    - a. PVC-Jacketed, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; PVC jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
      - 1) NFPA 70, Type CM.
      - 2) Flame Resistance: UL 1581, Vertical Tray.
    - b. Plenum-Type, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
      - 1) NFPA 70, Type CMP.
      - 2) Flame Resistance: NFPA 262, Flame Test.
- J. LAN Cables
1. Comply with Division 27 Section "Communications Horizontal Cabling".



2. RS-485 Cable:
  - a. PVC-Jacketed, RS-485 Cable: Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.
  - b. Plenum-Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket, and NFPA 70, Type CMP.
3. Unshielded Twisted Pair Cables: Category 5e **OR 6, as directed**, as specified for horizontal cable for data service in Division 27 Section "Communications Horizontal Cabling".

#### K. Low-Voltage Wiring

1. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.
  - a. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
  - b. Ordinary Switching Circuits: Three conductors, unless otherwise indicated.
  - c. Switching Circuits with Pilot Lights or Locator Feature: Five conductors, unless otherwise indicated.

### 1.3 EXECUTION

#### A. Cabling

1. Comply with NECA 1.
2. Install cables and wiring according to requirements in Division 27 Section "Communications Horizontal Cabling".
3. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.  
**OR**  
Wiring Method: Install wiring in raceway and cable tray 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. Use NRTL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
4. Install LAN cables using techniques, practices, and methods that are consistent with specified category rating of components and that ensure specified category performance of completed and linked signal paths, end to end.
5. Install cables without damaging conductors, shield, or jacket.

#### B. Identification

1. Identify components and power and control wiring according to Division 26 Section "Identification For Electrical Systems".
2. Label each power monitoring and control module with a unique designation.

#### C. Grounding

1. Comply with IEEE 1100, "Power and Grounding Sensitive Electronic Equipment."

#### 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. Electrical Tests: Use caution when testing devices containing solid-state components.
  - b. Continuity tests of circuits.
  - c. Operational Tests: Set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by



manufacturer. Submit sequences for approval. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.

- 1) Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
  - 2) Test LANs according to requirements in Division 27 Section "Communications Horizontal Cabling".
  - 3) System components with battery backup shall be operated on battery power for a period of not less than 10 percent of calculated battery operating time.
  - 4) Verify accuracy of graphic screens and icons.
  - 5) Metering Test: Load feeders, measure loads on feeder conductor with an rms reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.
  - 6) Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer.
3. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.
  4. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
  5. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.
  6. Remove and replace malfunctioning devices and circuits and retest as specified above.

E. Demonstration

1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain systems.
  - a. Train the Owner's management and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide a minimum of 12 hours' training.
  - b. Training Aid: Use approved final versions of software and maintenance manuals as training aids.

END OF SECTION 26 09 23 00b



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**SECTION 26 09 23 00c - MOTOR-CONTROL CENTERS****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for motor-control centers. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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 MCCs for use with ac circuits rated 600 V and less and having the following factory-installed components:
  - a. Incoming main lugs and OCPDs.
  - b. Full-voltage magnetic controllers.
  - c. Reduced-voltage magnetic controllers.
  - d. Reduced-voltage, solid-state controllers.
  - e. Multispeed controllers.
  - f. VFCs.
  - g. Feeder-tap units.
  - h. TVSS.
  - i. Instrumentation.
  - j. Auxiliary devices.

**C. Definitions**

1. BAS: Building automation system.
2. CE: Conformance Europeene (European Compliance).
3. CPT: Control power transformer.
4. EMI: Electromagnetic interference.
5. GFCI: Ground fault circuit interrupting.
6. IGBT: Insulated-gate bipolar transistor.
7. LAN: Local area network.
8. LED: Light-emitting diode.
9. MCC: Motor-control center.
10. MCCB: Molded-case circuit breaker.
11. MCP: Motor-circuit protector.
12. NC: Normally closed.
13. NO: Normally open.
14. OCPD: Overcurrent protective device.
15. PCC: Point of common coupling.
16. PID: Control action, proportional plus integral plus derivative.
17. PT: Potential transformer.
18. PWM: Pulse-width modulated.
19. RFI: Radio-frequency interference.
20. SCR: Silicon-controlled rectifier.
21. TDD: Total demand (harmonic current) distortion.
22. THD(V): Total harmonic voltage demand.
23. TVSS: Transient voltage surge suppressor.
24. VFC: Variable-frequency controller.

**D. Performance Requirements**

1. Seismic Performance: MCCs 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 controller and each type of MCC. Include shipping and operating weights, features, performance, electrical ratings, operating characteristics, and furnished specialties and accessories.
2. LEED Submittals:
  - a. Product Data for Credit EA 5: For continuous metering equipment for energy consumption.
3. Shop Drawings: For each MCC, manufacturer's approval, custom and production drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
  - a. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - 1) Each installed unit's type and details.
    - 2) Factory-installed devices.
    - 3) Enclosure types and details.
    - 4) Nameplate legends.
    - 5) Short-circuit current (withstand) rating of complete MCC, and for bus structure and each unit.
    - 6) Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
    - 7) Specified optional features and accessories.
  - b. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring for each installed controller.
  - c. Nameplate legends.
  - d. Vertical and horizontal bus capacities.
  - e. Features, characteristics, ratings, and factory settings of each installed unit.
4. Harmonic Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible **OR** designated, **as directed**, operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at each VFC **OR** at the defined PCC, **as directed**, to specified levels.
5. Standard Drawings: For each MCC, as defined in UL 845.
6. Production Drawings: For each MCC, as defined in UL 845.
7. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around MCCs where pipe and ducts are prohibited. Show MCC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
8. Seismic Qualification Certificates: For MCCs, 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.
9. Qualification Data: For qualified testing agency.
10. Product Certificates: For each MCC, from manufacturer.
11. Source quality-control reports.
12. Field quality-control reports.
13. Operation and Maintenance Data: For MCCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. Include the following:



- a. Manufacturer's Record Drawings: As defined in UL 845. In addition to requirements specified in UL 845, include field modifications and field-assigned wiring identification incorporated during construction by manufacturer, Contractor, or both.
  - b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
  - c. Manufacturer's written instructions for setting field-adjustable overload relays.
  - d. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage, solid-state controllers.
  - e. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
  - f. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
14. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
  15. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.
  16. Warranty: Sample of special warranty.
- F. Quality Assurance
1. 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.
  2. Source Limitations: Obtain MCCs and controllers of a single type from single source from single manufacturer.
  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. Comply with NFPA 70.
  5. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
- G. Delivery, Storage, And Handling
1. Deliver MCCs in shipping splits of lengths that can be moved past obstructions in delivery paths.
  2. Handle MCCs according to the following:
    - a. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."
    - b. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."
  3. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside MCCs; install temporary electric heating, with at least 250 W per vertical section **OR** connect factory-installed space heaters to temporary electrical service, **as directed**.
- H. Project Conditions
1. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Less than 0 deg F (minus 18 deg C) or exceeding 104 deg F (40 deg C), with an average value exceeding 95 deg F (35 deg C) over a 24-hour period.
    - b. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C).
    - c. Humidity: Less than 95 percent (noncondensing).
    - d. Altitude: Exceeding 6600 feet (2000 m), or 3300 feet (1000 m) if MCC includes solid-state devices.
  2. Interruption of Existing Electrical Service or Distribution Systems: Do not interrupt electrical service to, or distribution systems within, a facility 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. Indicate method of providing temporary electrical service.
  - c. Do not proceed with interruption of electrical service without the Owner's written permission.
  - d. Comply with NFPA 70E.
3. Product Selection for Restricted Space: Drawings indicate maximum dimensions for MCCs, including clearances between MCCs and adjacent surfaces and other items.

I. Coordination

1. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.
2. Coordinate features of MCCs, installed units, and accessory devices with remote pilot devices and control circuits to which they connect.
3. Coordinate features, accessories, and functions of each MCC, each controller, and each installed unit with ratings and characteristics of supply circuits, motors, required control sequences, and duty cycle of motors and loads.

J. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace TVSS **OR** VFCs, **as directed**, that fail in materials or workmanship within specified warranty period.
  - a. Warranty Period: Five years from date of Final Completion.

1.2 PRODUCTS

A. Manufactured Units

1. General Requirements for MCCs: Comply with NEMA ICS 18 and UL 845, **as directed**.

B. Functional Features

1. Description: Modular arrangement of main units, controller units, control devices, feeder-tap units, instruments, metering, auxiliary devices, and other items mounted in vertical sections of MCC.
2. Controller Units: Combination controller units.
  - a. Install units up to and including Size 3 on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
  - b. Equip units in Type B and Type C MCCs with pull-apart terminal strips for external control connections.
3. Feeder-Tap Units: Through 225-A rating shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
4. Future Units: Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.
5. Spare Units: Installed in compartments indicated "spare."

C. Incoming Mains

1. Incoming Mains Location: Top and bottom, **as directed**.
2. Main Lugs Only: Conductor connectors suitable for use with conductor material and sizes.
  - a. Material: Tin-plated aluminum **OR** Hard-drawn copper, 98 percent conductivity, **as directed**.
  - b. Main and Neutral Lugs: Compression **OR** Mechanical, **as directed**, type.



3. MCCB: Comply with UL 489, with series-connected rating **OR** interrupting capacity, **as directed**, to meet available fault currents.
  - a. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - b. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  - c. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
    - 1) Instantaneous trip.
    - 2) Long- and short-time pickup levels.
    - 3) Long- and short-time time adjustments.
    - 4) Ground-fault pickup level, time delay, and  $I^2t$  response.
  - d. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
  - e. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
  - f. MCCB Features and Accessories:
    - 1) Standard frame sizes, trip ratings, and number of poles.
    - 2) Lugs: Mechanical **OR** Compression, **as directed**, style, suitable for number, size, trip ratings, and conductor material.
    - 3) Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    - 4) Ground-Fault Protection: Integrally mounted **OR** Remote-mounted, **as directed**, relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    - 5) Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
    - 6) Communication Capability: Circuit-breaker-mounted **OR** Universal-mounted **OR** Integral **OR** Din-rail-mounted, **as directed**, communication module with functions and features compatible with power monitoring and control system specified in Division 16 Section "Electrical Power Monitoring and Control."
    - 7) Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 **OR** 75, **as directed**, percent of rated voltage.
    - 8) Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
    - 9) Auxiliary Contacts: One SPDT switch **OR** Two SPDT switches, **as directed**, with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
    - 10) Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
4. Insulated-Case Circuit Breaker: 80 **OR** 100, **as directed**, percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
  - a. Fixed **OR** Drawout, **as directed**, circuit-breaker mounting.
  - b. Two-step, stored-energy closing.
  - c. Standard **OR** Full, **as directed**, -function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
    - 1) Instantaneous trip.
    - 2) Long- and short-time time adjustments.
    - 3) Ground-fault pickup level, time delay, and  $I^2t$  response.
  - d. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
  - e. Remote trip indication and control.



- f. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 16 Section "Electrical Power Monitoring and Control."
- g. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- h. Control Voltage: 40-V dc **OR** 125-V dc **OR** 250-V dc **OR** 120-V ac, **as directed**.

#### D. Combination Controllers

1. Full-Voltage Controllers:
  - a. General Requirements for Full-Voltage Enclosed Controllers: Comply with NEMA ICS 2, general purpose, Class A.
  - b. Magnetic Controllers: Full voltage, across the line, electrically held.
    - 1) Configuration: Nonreversing and reversing.
2. Reduced-Voltage Magnetic Controllers:
  - a. General Requirements for Reduced-Voltage Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A; closed transition; adjustable time delay on transition.
  - b. Reduced-Voltage Magnetic Controllers: Reduced voltage, electrically held.
    - 1) Configuration:
      - a) Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.
      - b) Part-Winding Controller: Separate START and RUN contactors, field-selectable for one-half or two-thirds winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
      - c) Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.
3. Reduced-Voltage, Solid-State Controllers:
  - a. General Requirements for Reduced-Voltage, Solid-State Controllers: Comply with UL 508.
  - b. Reduced-Voltage, Solid-State Controllers: An integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relay; suitable for use with NEMA MG 1, Design B, polyphase, medium-induction motors.
    - 1) Configuration: Standard duty **OR** Severe duty, **as directed**; nonreversible **OR** reversible, **as directed**.
    - 2) Starting Mode: Voltage ramping **OR** Current limit **OR** Torque control **OR** Torque control with voltage boost, **as directed**; field selectable, **as directed**.
    - 3) Stopping Mode: Coast to stop **OR** Adjustable torque deceleration **OR** Adjustable braking, **as directed**; field selectable, **as directed**.
    - 4) Shorting (Bypass) Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Solid-state controller protective features shall remain active when the shorting contactor is in the bypass mode.
    - 5) Shorting and Input Isolation, **as directed**, Contactor Coils: Pressure-encapsulated type; manufacturer's standard operating voltage, matching control power or line voltage, depending on contactor size and line-voltage rating. Provide coil transient suppressors, **as directed**.
    - 6) Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
    - 7) Adjustable acceleration-rate control using voltage or current ramp, and adjustable starting torque control with up to 400 percent current limitation for 20 seconds.
    - 8) SCR bridge shall consist of at least two SCRs per phase, providing stable and smooth acceleration with **OR** without, **as directed**, external feedback from the motor or driven equipment.



- 9) Keypad, front accessible; for programming the controller parameters, functions, and features; shall be manufacturer's standard and include not less than the following functions:
    - a) Adjusting motor full-load amperes, as a percentage of the controller's rating.
    - b) Adjusting current limitation on starting, as a percentage of the motor full-load current rating.
    - c) Adjusting linear acceleration and deceleration ramps, in seconds.
    - d) Initial torque, as a percentage of the nominal motor torque.
    - e) Adjusting torque limit, as a percentage of the nominal motor torque.
    - f) Adjusting maximum start time, in seconds.
    - g) Adjusting voltage boost, as a percentage of the nominal supply voltage.
    - h) Selecting stopping mode, and adjusting parameters.
    - i) Selecting motor thermal-overload protection class between 5 and 30.
    - j) Activating and de-activating protection modes.
    - k) Selecting or activating communications modes.
  - 10) Digital display, front accessible; for showing motor, controller, and fault status; shall be manufacturer's standard and include not less than the following:
    - a) Controller Condition: Ready, starting, running, stopping.
    - b) Motor Condition: Amperes, voltage, power factor, power, and thermal state.
    - c) Fault Conditions: Controller thermal fault, motor overload alarm and trip, motor underload, overcurrent, shorted SCRs, line or phase loss, phase reversal, and line frequency over or under normal.
  - 11) Controller Diagnostics and Protection:
    - a) Microprocessor-based thermal protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor overload alarm and trip; settings selectable via the keypad.
    - b) Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and underload conditions; and line frequency over or under normal.
    - c) Input isolation contactor that opens when the controller diagnostics detect a faulted solid-state component, or when the motor is stopped.  
**OR**  
Shunt trip that opens the disconnecting means when the controller diagnostics detect a faulted solid-state component.
  - 12) Remote Output Features:
    - a) All outputs prewired to terminal blocks.
    - b) Form C status contacts that change state when controller is running.
    - c) Form C alarm contacts that change state when a fault condition occurs.
  - 13) Optional Features:
    - a) Analog output for field-selectable assignment of motor operating characteristics; 0 to 10-V dc **OR** 4 to 20-mA dc, **as directed**.
    - b) Additional field-assignable Form C contacts for alarm outputs.
    - c) Surge suppressors in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
    - d) Full-voltage bypass contactor operating automatically **OR** manually, with NORMAL/BYPASS selector switch, **as directed**. Power contacts shall be totally enclosed, double break, and silver-cadmium oxide; and assembled to allow inspection and replacement without disturbing line or load wiring.
4. Multispeed Magnetic Controllers:
- a. General Requirements for Multispeed Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A.
  - b. Multispeed Magnetic Controllers: Two speed, full voltage, across the line, electrically held. Compelling relay to ensure that motor will start only at low speed.
    - 1) Configuration: Nonreversing **OR** Reversing, **as directed**; consequent pole **OR** two winding, **as directed**.



- 2) Compelling relays shall ensure that motor starts only at low speed.
  - 3) Accelerating timer relays shall ensure properly timed acceleration through speeds lower than that selected.
  - 4) Decelerating timer relays shall ensure automatically timed deceleration through each speed.
  - 5) Antiplugging timer relays shall ensure a time delay when transferring from FORWARD to REVERSE and back.
5. Disconnecting Means and OCPDs:
- a. Fusible Disconnecting Means:
    - 1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class J **OR** Class L, **as directed**, fuses.
    - 2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - 3) Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
  - b. MCP Disconnecting Means:
    - 1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
    - 2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - 3) Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
    - 4) NC **OR** NO, **as directed**, alarm contact that operates only when MCP has tripped.
    - 5) Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
  - c. MCCB Disconnecting Means:
    - 1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
    - 2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    - 3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - 4) Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
    - 5) NC **OR** NO, **as directed**, alarm contact that operates only when MCCB has tripped.
  - d. Molded-Case Switch Disconnecting Means:
    - 1) UL 489, NEMA AB 1, and NEMA AB 3, with in-line fuse block for Class J or L power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
    - 2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - 3) Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
    - 4) NC **OR** NO, **as directed**, alarm contact that operates only when molded-case switch has tripped.
6. Overload Relays:
- a. Melting-Alloy Overload Relays:
    - 1) Inverse-time-current characteristic.
    - 2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
    - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
  - b. Bimetallic Overload Relays:
    - 1) Inverse-time-current characteristic.
    - 2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
    - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
    - 4) Ambient compensated.



- 5) Automatic resetting.
  - c. Solid-State Overload Relays:
    - 1) Switch or dial selectable for motor running overload protection.
    - 2) Sensors in each phase.
    - 3) Class 10 **OR** Class 20 **OR** Class 10/20 selectable, **as directed**, tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
      - a) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
      - b) Analog communication module.
  - d. NC **OR** NO, **as directed**, isolated overload alarm contact.
  - e. External overload reset push button.
  7. Control Power:
    - a. Control Circuits: 24 **OR** 120, **as directed**, -V ac; obtained from integral CPT, with primary and secondary fuses, with CPT **OR** control power source, **as directed**, of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
      - 1) CPT Spare Capacity: 50 **OR** 100 **OR** 200, **as directed**, VA.
- E. VFCS
1. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C, **as directed**.
  2. Application: Constant torque and variable torque, **as directed**.
  3. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
    - a. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
    - b. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
    - c. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
    - d. Listed and labeled for single-phase use by an NRTL acceptable to authorities having jurisdiction.
  4. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
  5. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range **OR** 66 Hz, with torque constant as speed changes, **as directed**; maximum voltage equals input voltage.
  6. Unit Operating Requirements:
    - a. Input AC Voltage Tolerance: Plus 10 and minus 10 **OR** 15, **as directed**, percent of VFC input voltage rating.
    - b. Input AC Voltage Unbalance: Not exceeding 3 **OR** 5, **as directed**, percent.
    - c. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
    - d. Minimum Efficiency: 96 **OR** 97, **as directed**, percent at 60 Hz, full load.
    - e. Minimum Displacement Primary-Side Power Factor: 96 **OR** 98, **as directed**, percent under any load or speed condition.
    - f. Overload Capability: 1.1 **OR** 1.5, **as directed**, times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
    - g. Starting Torque: Minimum of 100 percent of rated torque from 3 to 60 Hz.
    - h. Speed Regulation: Plus or minus 5 **OR** 10, **as directed**, percent.
    - i. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.



- j. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- 7. Inverter Logic: Microprocessor based, 16 **OR** 32, **as directed**, bit, isolated from all power circuits.
- 8. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
  - a. Signal: Electrical.  
**OR**  
Signal: Pneumatic.
- 9. Internal Adjustability Capabilities:
  - a. Minimum Speed: 5 to 25 percent of maximum rpm.
  - b. Maximum Speed: 80 to 100 percent of maximum rpm.
  - c. Acceleration: 0.1 to 999.9 seconds.
  - d. Deceleration: 0.1 to 999.9 seconds.
  - e. Current Limit: 30 to a minimum of 150 percent of maximum rating.
- 10. Self-Protection and Reliability Features:
  - a. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
  - b. Loss of Input Signal Protection: Selectable response strategy including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
  - c. Under- and overvoltage trips.
  - d. Inverter overcurrent trips.
  - e. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
  - f. Critical frequency rejection, with three selectable, adjustable deadbands.
  - g. Instantaneous line-to-line and line-to-ground overcurrent trips.
  - h. Loss-of-phase protection.
  - i. Reverse-phase protection.
  - j. Short-circuit protection.
  - k. Motor overtemperature fault.
- 11. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- 12. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
- 13. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- 14. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- 15. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- 16. Integral Input Disconnecting Means and OCPD: NEMA AB 1, instantaneous-trip circuit breaker **OR** NEMA AB 1, molded-case switch, with power fuse block and current-limiting fuses **OR** NEMA AB 1, thermal-magnetic circuit breaker **OR** NEMA KS 1, nonfusible switch, with power fuse block and current-limiting fuses **OR** NEMA KS 1, fusible switch, **as directed**, with pad-lockable, door-mounted handle mechanism.
  - a. Disconnect Rating (for VFCs without bypass systems): Not less than 115 percent of VFC input current rating.
  - b. Disconnect Rating (for VFCs with bypass systems): Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
  - c. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.



- d. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
- e. NC **OR** NO, **as directed**, alarm contact that operates only when circuit breaker has tripped.

F. VFC Controls And Indication

1. Status Lights: Door-mounted LED indicators displaying the following conditions:
  - a. Power on.
  - b. Run.
  - c. Overvoltage.
  - d. Line fault.
  - e. Overcurrent.
  - f. External fault.
2. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
  - a. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
  - b. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
    - 1) Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
3. Historical Logging Information and Displays:
  - a. Running log of total power versus time.
  - b. Total run time.
  - c. Fault log, maintaining last four faults with time and date stamp for each.
4. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters, including, but not limited to:
  - a. Output frequency (Hz).
  - b. Motor speed (rpm).
  - c. Motor status (running, stop, fault).
  - d. Motor current (amperes).
  - e. Motor torque (percent).
  - f. Fault or alarming status (code).
  - g. PID feedback signal (percent).
  - h. DC-link voltage (V dc).
  - i. Set point frequency (Hz).
  - j. Motor output voltage (V ac).
5. Control Signal Interfaces:
  - a. Electric Input Signal Interface:
    - 1) A minimum of two programmable analog inputs: 0- to 10-V dc **OR** 4- to 20-mA dc **OR** Operator-selectable "x"- to "y"-mA dc, **as directed**.
    - 2) A minimum of six multifunction programmable digital inputs.
  - b. Pneumatic Input Signal Interface: 3 to 15 psig (20 to 104 kPa).
  - c. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
    - 1) 0- to 10-V dc.
    - 2) 4- to 20-mA dc.
    - 3) Potentiometer using up/down digital inputs.
    - 4) Fixed frequencies using digital inputs.
  - d. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc **OR** 4- to 20-mA dc **OR** operator-selectable "x"- to "y"-mA dc, **as directed**), which can be configured for any of the following:
    - 1) Output frequency (Hz).
    - 2) Output current (load).



- 3) DC-link voltage (V dc).
  - 4) Motor torque (percent).
  - 5) Motor speed (rpm).
  - 6) Set point frequency (Hz).
  - e. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
    - 1) Motor running.
    - 2) Set point speed reached.
    - 3) Fault and warning indication (overtemperature or overcurrent).
    - 4) PID high- or low-speed limits reached.
  6. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.
    - a. Number of Loops: One **OR** Two, **as directed**.
  7. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms and energy usage, **as directed**. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.
    - a. Network Communications Ports: Ethernet and RS-422/485.
    - b. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet **OR** Echelon LonWorks **OR** Ethernet TCP/IP **OR** Johnson Metasys N2 **OR** Modbus/Memobus **OR** Siemens System 600 APOGEE, **as directed**; protocols accessible via the communications ports.
- G. VFC Line Conditioning And Filtering
1. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD at input terminals of VFCs to less than 5 **OR** 8, **as directed**, percent and THD(V) to 3 **OR** 5, **as directed**, percent.
  2. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD and THD(V) at the defined PCC per IEEE 519.
  3. Input Line Conditioning: **<Insert requirements>**.
  4. VFC Output Filtering: **<Insert requirements>**.
  5. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.
- H. VFC Bypass Systems
1. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes, and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
  2. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.  
**OR**  
Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.
  3. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode, **as directed**.
    - a. Bypass Contactor: Load-break, IEC **OR** NEMA, **as directed**, -rated contactor.
    - b. Output Isolating Contactor: Non-load-break, IEC **OR** NEMA, **as directed**, -rated contactor.
    - c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

**OR**

Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier, **as directed**, arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.

- a. Bypass Contactor: Load-break, IEC **OR** NEMA, **as directed**, -rated contactor.
  - b. Input and Output Isolating Contactors: Non-load-break, IEC **OR** NEMA, **as directed**, -rated contactors.
  - c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
4. Bypass Contactor Configuration: Full-voltage (across-the-line) **OR** Reduced-voltage (autotransformer), **as directed**, type.
- a. NORMAL/BYPASS selector switch.
  - b. HAND/OFF/AUTO selector switch.
  - c. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
  - d. Contactor Coils: Pressure-encapsulated type with coil transient suppressors, **as directed**.
    - 1) Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
    - 2) Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
  - e. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses **as directed**, with CPT **OR** control power source, **as directed**, of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
  - f. CPT Spare Capacity: 50 **OR** 100 **OR** 200, **as directed**, VA.
5. Overload Relays: NEMA ICS 2.
- a. Melting-Alloy Overload Relays:
    - 1) Inverse-time-current characteristic.
    - 2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
    - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
  - b. Bimetallic Overload Relays:
    - 1) Inverse-time-current characteristic.
    - 2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
    - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
    - 4) Ambient compensated.
    - 5) Automatic resetting.
  - c. Solid-State Overload Relays:
    - 1) Switch or dial selectable for motor-running overload protection.
    - 2) Sensors in each phase.
    - 3) Class 10 **OR** Class 20 **OR** Class 10/20 selectable, **as directed**, tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
    - 4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
    - 5) Analog communication module.
    - 6) NC **OR** NO, **as directed**, isolated overload alarm contact.
    - 7) External overload reset push button.
- I. Optional VFC Features
1. Multiple-Motor Capability: VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications, when overload protection activates.



- a. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.
- b. Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.
- c. Configure to allow two motors to operate simultaneously and in a lead/lag mode, with one motor operated at variable speed via the power converter and the other at constant speed via the bypass controller; separate overload relay for each controlled motor.
2. Damper control circuit with end of travel feedback capability.
3. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.
4. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.
5. Firefighter's Override (Smoke Purge) Input: On a remote contact closure from the firefighter's control station **OR** smoke-control fan controller, **as directed**, this password-protected input:
  - a. Overrides all other local and external inputs (analog/digital, serial communication, and all keypad commands).
  - b. Forces VFC to operate motor, without any other run or speed command, at a field-adjustable, preset speed.  
**OR**  
Forces VFC to transfer to Bypass Mode and operate motor at full speed.
  - c. Causes display of Override Mode on the VFC display.
  - d. Reset VFC to normal operation on removal of override signal automatically **OR** manually, **as directed**.
6. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.
7. Remote digital operator kit.
8. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

#### J. Feeder-Tap Units

1. MCCB: Comply with UL 489, with series-connected rating **OR** interrupting capacity, **as directed**, to meet available fault currents.
  - a. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - b. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  - c. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
    - 1) Instantaneous trip.
    - 2) Long- and short-time pickup levels.
    - 3) Long- and short-time time adjustments.
    - 4) Ground-fault pickup level, time delay, and  $I^2t$  response.
  - d. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
  - e. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
  - f. MCCB Features and Accessories:
    - 1) Standard frame sizes, trip ratings, and number of poles.
    - 2) Lugs: Mechanical **OR** Compression, **as directed**, style, suitable for number, size, trip ratings, and conductor material.
    - 3) Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.



- 4) Ground-Fault Protection: Integrally mounted **OR** Remote-mounted, **as directed**, relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  - 5) Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
  - 6) Communication Capability: Circuit-breaker-mounted **OR** Universal-mounted **OR** Integral **OR** Din-rail-mounted, **as directed**, communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring And Control".
  - 7) Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 **OR** 75, **as directed**, percent of rated voltage.
  - 8) Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
  - 9) Auxiliary Contacts: One SPDT switch **OR** Two SPDT switches, **as directed**, with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
  - 10) Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
2. Fusible Switch: NEMA KS 1, Type HD, clips to accommodate specified fuses with lockable handle.
  3. Fuses are specified in Division 26 Section "Fuses".

K. Transient Voltage Suppression Devices

1. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, wired-in **OR** plug-in **OR** bolt-on, **as directed**, solid-state, parallel-connected, modular (with field-replaceable modules) **OR** non-modular, **as directed**, type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the MCC short-circuit rating, and with the following features and accessories:
  - a. Fuses, rated at 200-kA interrupting capacity.
  - b. Fabrication using bolted compression lugs for internal wiring.
  - c. Integral disconnect switch.
  - d. Redundant suppression circuits.
  - e. Redundant replaceable modules.
  - f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
  - g. LED indicator lights for power and protection status.
  - h. Audible alarm, with silencing switch, to indicate when protection has failed.
  - i. Form-C contacts rated at 5 A and 250-V ac, one NO and one NC, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
  - j. Four **OR** Six, **as directed**, -digit, transient-event counter set to totalize transient surges.
2. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase **OR** 120 kA per mode/240 kA per phase **OR** 80 kA per mode/160 kA per phase, **as directed**.
3. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
4. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 **OR** 208Y/120 **OR** 600Y/347, **as directed**, -V, three-phase, four-wire circuits shall be as follows:
  - a. Line to Neutral: 800 V for 480Y/277 **OR** 400 V for 208Y/120 **OR** 1200 V for 600Y/347, **as directed**.
  - b. Line to Ground: 800 V for 480Y/277 **OR** 400 V for 208Y/120 **OR** 1200 V for 600Y/347, **as directed**.
  - c. Neutral to Ground: 800 V for 480Y/277 **OR** 400 V for 208Y/120 **OR** 1200 V for 600Y/347, **as directed**.

**OR**

Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:



- a. Line to Neutral: 400 V, 800 V from high leg.
- b. Line to Ground: 400 V.
- c. Neutral to Ground: 400 V.

**OR**

Protection modes and UL 1449 SVR for 240-, 480-, or 600-V, three-phase, three-wire, delta circuits shall be as follows:

- a. Line to Line: 2000 V for 480 V **OR** 1000 V for 240 V **OR** 2500 V for 600 V, **as directed**.
- b. Line to Ground: 1500 V for 480 V **OR** 800 V for 240 V **OR** 2500 V for 600 V, **as directed**.

## L. Instrumentation

1. Instrument Transformers (for the Owner metering): IEEE C57.13, NEMA EI 21.1, and the following:
  - a. PTs: IEEE C57.13; 120 V, 60 Hz, single **OR** tapped **OR** double, **as directed**, secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
  - b. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound **OR** bushing **OR** bar or window, **as directed**, type; single **OR** double, **as directed**, secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
  - c. CPTs: Dry type, mounted in separate compartments for units larger than 3 kVA.
  - d. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
2. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
  - a. Listed or recognized by a nationally recognized testing laboratory.
  - b. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
  - c. Switch-selectable digital display of the following values with the indicated maximum accuracy tolerances:
    - 1) Phase Currents, Each Phase: Plus or minus 1 percent.
    - 2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
    - 3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
    - 4) Three-Phase Real Power (Megawatts): Plus or minus 2 percent.
    - 5) Three-Phase Reactive Power (Megavars): Plus or minus 2 percent.
    - 6) Power Factor: Plus or minus 2 percent.
    - 7) Frequency: Plus or minus 0.5 percent.
    - 8) Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
    - 9) Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
    - 10) Contact devices to operate remote impulse-totalizing demand meter.
  - d. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
3. Ammeters, Voltmeters, and Power-Factor Meters: ANSI C39.1.
  - a. Meters: 4-inch (100-mm) diameter or 6 inches (150 mm) square, flush or semiflush, with antiparallax 250-degree scale and external zero adjustment.
  - b. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.
4. Instrument Switches: Rotary type with off position.
  - a. Voltmeter Switches: Permit reading of all phase-to-phase voltages and phase-to-neutral voltages where a neutral is included.
  - b. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.



5. Feeder Ammeters: 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for feeder circuits, unless otherwise indicated.
  6. Watt-Hour Meters and Wattmeters:
    - a. Comply with ANSI C12.1.
    - b. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
    - c. Suitable for connection to three- and four-wire circuits.
    - d. Potential indicating lamps.
    - e. Adjustments for light and full load, phase balance, and power factor.
    - f. Four-dial clock register.
    - g. Integral demand indicator.

**OR**

Contact devices to operate remote impulse-totalizing demand meter.

    - h. Ratchets to prevent reverse rotation.
    - i. Removable meter with drawout test plug.
    - j. Semiflush mounted case with matching cover.
    - k. Appropriate multiplier tag.
  7. Impulse-Totalizing Demand Meter:
    - a. Comply with ANSI C12.1.
    - b. Suitable for use with MCC watt-hour meter, including two-circuit totalizing relay.
    - c. Cyclometer.
    - d. Four-dial, totalizing kilowatt-hour register.
    - e. Positive chart drive mechanism.
    - f. Capillary pen holding a minimum of one month's ink supply.
    - g. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
    - h. Capable of indicating and recording five **OR 15 OR 30, as directed**,-minute integrated demand of totalized system.
- M. MCC Control Power
1. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from CPT.  
**OR**  
Control Circuits: 120-V ac, supplied from remote branch circuit.
  2. Electrically Interlocked Main and Tie Circuit Breakers: Two CPTs in separate compartments, with interlocking relays, connected to the primary side of each CPT at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.
  3. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
  4. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
- N. Enclosures
1. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, Type 1 **OR** Type 1A **OR** Type 2 **OR** Type 12, **as directed**, unless otherwise indicated to comply with environmental conditions at installed location.
  2. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
    - a. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point **OR** Manual switching of branch-circuit protective device, **as directed**.
    - b. Space-Heater Power Source: Transformer, factory installed in MCC **OR** 120-V external branch circuit, **as directed**.
  3. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray **OR** custom color, **as directed**, finish over a rust-inhibiting primer on treated metal surface.



4. Outdoor Enclosures: Type 3R, non-walk-in aisle **OR** Type 3R, with interior-lighted walk-in aisle, **as directed**.
    - a. Finish: Factory-applied finish in manufacturer's standard **OR** custom, **as directed**, color; undersurfaces treated with corrosion-resistant undercoating.
    - b. Enclosure: Flat **OR** Downward, rearward sloping, **as directed**, roof; bolt-on rear covers **OR** rear hinged doors, **as directed**, for each section, with provisions for padlocking.
    - c. Doors: Personnel door at each end of aisle, minimum width of 30 inches (762 mm); opening outwards; with panic hardware and provisions for padlocking **OR** cylinder lock, **as directed**.
    - d. Accessories: Fluorescent lighting fixtures, ceiling mounted; wired to a three-way light switch at each end of aisle; GFCI duplex receptacle; emergency battery pack lighting fixture installed on wall of aisle midway between personnel doors.
    - e. Walk-in Aisle Heating and Ventilating:
      - 1) Factory-installed electric unit heater(s), wall or ceiling mounted, with integral thermostat and disconnect and with capacities to maintain switchboard interior temperature of 40 deg F (5 deg C) with outside design temperature of 104 deg F (40 deg C).
      - 2) Factory-installed exhaust fan with capacities to maintain switchboard interior temperature of 100 deg F (38 deg C) with outside design temperature of 23 deg F (minus 5 deg C).
      - 3) Ventilating openings complete with replaceable fiberglass air filters, **as directed**.
      - 4) Thermostat: Single stage; wired to control heat and exhaust fan.
    - f. Power for Space Heaters, Ventilation, Lighting, and Receptacle: Include a CPT within the switchboard. Supply voltage shall be 120 **OR** 120/240 **OR** 120/208, **as directed**, -V ac.  
**OR**  
Power for space heaters, ventilation, lighting, and receptacle provided by a remote source.
  5. Compartments: Modular; individual lift-off, **as directed**, doors with concealed hinges and quick-captive screw fasteners. Interlocks on units requiring disconnecting means in off position before door can be opened or closed, except by operating a permissive release device.
  6. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
  7. Wiring Spaces:
    - a. Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
    - b. Horizontal wireways in bottom **OR** top **OR** bottom and top, **as directed**, of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.
- O. Auxiliary Devices
1. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
    - a. Push Buttons, Pilot Lights, and Selector Switches: Heavy **OR** Standard, **as directed**, -duty, oiltight, **as directed**, type.
      - 1) Push Buttons: Covered **OR** Lockable **OR** Recessed **OR** Shielded **OR** Shrouded **OR** Unguarded, **as directed**, types; maintained **OR** momentary, **as directed**, contact unless otherwise indicated.
      - 2) Pilot Lights: Incandescent **OR** LED **OR** Neon **OR** Resistor **OR** Transformer, **as directed**, types; <Insert color(s)>; push to test, **as directed**.
      - 3) Selector Switches: Rotary type.
    - b. Elapsed-Time Meters: Heavy duty with digital readout in hours; nonresettable **OR** resettable, **as directed**.
    - c. Meters: Panel type, 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy with selector switches having an off position.
  2. NC **OR** NO **OR** Reversible NC/NO, **as directed**, contactor auxiliary contact(s).



3. Control Relays: Auxiliary and adjustable pneumatic **OR** solid-state, **as directed**, time-delay relays.
4. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
5. Space heaters, with NC auxiliary contacts, to mitigate condensation in enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
6. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
7. Cover gaskets for Type 1 enclosures.
8. Terminals for connecting power factor correction capacitors to the line **OR** load, **as directed**, side of overload relays.
9. Spare control-wiring terminal blocks; unwired **OR** wired, **as directed**.
10. Spare-Fuse Cabinet: Identified and compartmented steel box **OR** cabinet with hinged lockable door, **as directed**.

P. Characteristics And Ratings

1. Wiring: NEMA ICS 18, Class I **OR** Class I-S, **as directed**, Type A **OR** Type B, for starters above Size 3 **OR** Type B-D, for starter Size 3 and below **OR** Type B-T, for starter Size 3 and below **OR** Type C, **as directed**.  
**OR**  
Wiring: NEMA ICS 18, Class II **OR** Class II-S, **as directed**, Type B, for starters above Size 3 **OR** Type B-D, for starter Size 3 and below **OR** Type B-T, for starter Size 3 and below **OR** Type C, **as directed**.
2. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
3. Nominal System Voltage: 480 V, three phase, three wire **OR** 480Y/277 V, three phase, four wire, **as directed**.  
**OR**  
Nominal System Voltage: 208 V, three phase, three wire **OR** 208/120 V, three phase, four wire, **as directed**.
4. Short-Circuit Current Rating for Each Unit: Combination series rated **OR** Fully rated, **as directed**; 22 **OR** 42 **OR** 65 **OR** 100, **as directed**, kA.
5. Short-Circuit Current Rating of MCC: Combination series rated **OR** Fully rated, **as directed**, with its main overcurrent device; 22 **OR** 42 **OR** 65 **OR** 100, **as directed**, kA.
6. Environmental Ratings:
  - a. Ambient Temperature Rating: Not less than 0 deg F (minus 18 deg C) and not exceeding 104 deg F (40 deg C), with an average value not exceeding 95 deg F (35 deg C) over a 24-hour period.
  - b. Ambient Storage Temperature Rating: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C)
  - c. Humidity Rating: Less than 95 percent (noncondensing).
  - d. Altitude Rating: Not exceeding 6600 feet (2000 m), or 3300 feet (1000 m) if MCC includes solid-state devices.
7. Main-Bus Continuous Rating: 600 **OR** 800 **OR** 1000 **OR** 1200 **OR** 1600 **OR** 2000, **as directed**, A.
8. Vertical-Bus Minimum, **as directed**, Continuous Rating: 300 **OR** 600 **OR** 1200, **as directed**, A.
9. Horizontal and Vertical Bus Bracing (Short-Circuit Current Rating): Match MCC short-circuit current rating.
10. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions from both ends, **as directed**. Brace bus extensions for busway feeder bus, **as directed**.
11. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.



12. Phase- and Neutral-, **as directed**, Bus Material: Hard-drawn copper of 98 percent conductivity, silver **OR** tin, **as directed**, plated.  
**OR**  
Phase- and Neutral-, **as directed**, Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy.
  13. Neutral Buses: 50 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical **OR** compression, **as directed**, connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus, **as directed**.  
**OR**  
Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical **OR** compression, **as directed**, connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus, **as directed**.
  14. Ground Bus: Minimum size required by UL 845, hard-drawn copper of 98 percent conductivity, equipped with mechanical **OR** compression, **as directed**, connectors for feeder and branch-circuit equipment grounding conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run, **as directed**.
  15. Front-Connected, Front-Accessible MCCs:
    - a. Main Devices: Drawout **OR** Fixed, **as directed**, mounted.
    - b. Controller Units: Drawout and fixed, **as directed**, mounted.
    - c. Feeder-Tap Units: Drawout and fixed, **as directed**, mounted.
    - d. Sections front and rear aligned.
  16. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic MCC. Provide service entrance label and necessary applicable service entrance features.
  17. the Owner Metering Compartment: A separate customer metering compartment and section with front hinged door, metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks, **as directed**.
  18. Bus Transition and Incoming Pull Sections: Matched and aligned with basic MCC.
  19. Pull Box on Top of an MCC:
    - a. Adequate ventilation to maintain temperature in pull box within same limits as MCC.
    - b. Set back from front to clear circuit-breaker removal mechanism.
    - c. Removable covers forming top, front, and sides. Top covers at rear easily removable for drilling and cutting.
    - d. Insulated bottom of fire-resistive material with separate holes for cable drops into MCC.
    - e. Cable supports arranged to facilitate cabling and adequate to support cables, including those for future installation.
    - f. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
  20. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of unit.
  21. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.
  22. Fungus Proofing: Permanent fungicidal treatment for OCPDs and other components including instruments and instrument transformers.
- Q. Source Quality Control
1. MCC Testing: Inspect and test MCCs according to requirements in NEMA ICS 18.
  2. VFC Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
    - a. Test each VFC while connected to its specified motor **OR** a motor that is comparable to that for which the VFC is rated, **as directed**.



- b. Verification of Performance: Rate VFCs according to operation of functions and features specified.
3. MCCs will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

### 1.3 EXECUTION

#### A. Examination

1. Examine areas and surfaces to receive MCCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
2. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

#### B. Harmonic Analysis Study

1. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible **OR** designated, **as directed**, operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at the defined PCC to specified levels.
2. Prepare a harmonic analysis study report complying with IEEE 399 and NETA Acceptance Testing Specification.

#### C. Installation

1. Coordinate layout and installation of MCCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
2. Floor-Mounting Controllers: Install MCCs on 4-inch (100-mm) nominal thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
  - a. 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.
  - b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - d. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
4. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
5. Install fuses in each fusible switch.
6. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses".
7. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
8. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
9. Install power factor correction capacitors. Connect to the line **OR** load, **as directed**, side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.
10. Comply with NECA 1.

#### D. Identification

1. Comply with requirements in Division 26 Section "Identification For Electrical Systems" for identification of MCC, MCC components, and control wiring.



- a. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - b. Label MCC and each cubicle with engraved nameplate.
  - c. Label each enclosure-mounted control and pilot device.
  - d. Mark up a set of manufacturer's connection wiring diagrams with field-assigned wiring identifications and return to manufacturer for inclusion in Record Drawings.
2. Operating Instructions: Frame printed operating instructions for MCCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of MCCs.
- E. Control Wiring Installation
1. Install wiring between enclosed controllers **OR** master terminal boards, **as directed**, and remote devices and facility's BAS **OR** and facility's central-control system, **as directed**. Comply with requirements in Division 26 Section "Control-voltage Electrical Power Cables".
  2. Bundle, train, and support wiring in enclosures.
  3. Connect selector switches and other automatic-control selection devices where applicable.
    - a. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
    - b. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.
- F. Connections
1. Comply with requirements for installation of conduit in Division 26 Section "Raceway And Boxes For Electrical Systems". Drawings indicate general arrangement of conduit, fittings, and specialties.
  2. Comply with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems".
- G. Field Quality Control
1. Perform tests and inspections.
  2. Acceptance Testing Preparation:
    - a. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
    - b. Test continuity of each circuit.
  3. Tests and Inspections:
    - a. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
    - b. Test insulation resistance for each enclosed controller element, component, connecting motor supply, feeder, and control circuits.
    - c. Test continuity of each circuit.
    - d. Verify that voltages at controller locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify the Owner before starting the motor(s).
    - e. Test each motor for proper phase rotation.
    - f. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
    - g. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
    - h. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
      - 1) Initial Infrared Scanning: After Final Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multipole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
      - 2) Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multipole enclosed controller 11 months after date of Final Completion.



- 3) Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    - i. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
    - j. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.
  4. Enclosed controllers will be considered defective if they do not pass tests and inspections.
  5. Prepare test and inspection reports, including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- H. Startup Service
1. Perform startup service.
    - a. Complete installation and startup checks according to manufacturer's written instructions.
- I. Adjusting
1. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
  2. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
  3. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify the Owner before increasing settings.
  4. Set the taps on reduced-voltage autotransformer controllers at 50 **OR** 65 **OR** 80, **as directed**, percent.
  5. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.
  6. Program microprocessors in VFCs for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Final Completion.
  7. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".
- J. Protection
1. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
  2. Replace controllers whose interiors have been exposed to water or other liquids prior to Final Completion.
- K. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage, solid-state controllers, **as directed**.

END OF SECTION 26 09 23 00c



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## SECTION 26 09 23 00d - CENTRAL DIMMING CONTROLS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for central dimming controls. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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 microprocessor-based central dimming controls with the following components:
  - a. Control network.
  - b. Master-control stations.
  - c. Partitioned-space master-control stations.
  - d. Wall stations.
  - e. Dimmer cabinets.
  - f. Manual switches and plates for controlling dimmers.

#### C. Definitions

1. Fade Override: The ability to temporarily set fade times to zero for all lighting scenes.
2. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.
3. Fade Time: The time it takes all zones to fade from one lighting scene to another, with all zones arriving at the next scene at the same time.
4. Low Voltage: As defined in NFPA 70, term for circuits and equipment operating at less than 50 V or for remote-control, signaling, and power-limited circuits.
5. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.
6. SCR: Silicon-controlled rectifier.
7. Zone: A fixture or group of fixtures controlled simultaneously as a single entity. Also known as a "channel."

#### D. Submittals

1. Product Data: For each type of product indicated.
  - a. For central dimming controls; include elevation, features, characteristics, and labels.
  - b. For dimmer panels; include dimensions, features, dimmer characteristics, ratings, and directories.
  - c. Device plates, plate color, and material.
  - d. Ballasts and lamp combinations compatible with dimmer controls.
  - e. Sound data including results of operational tests of central dimming controls.
  - f. Operational documentation for software and firmware.
2. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
  - a. Include elevation views of front panels of control and indicating devices and control stations.
  - b. Wiring Diagrams: Power, signal, and control wiring.
3. Samples: For master-control stations, partitioned-space master-control stations, wall stations, dimmer cabinets, and faceplates with factory-applied color finishes and technical features.
  - a. Operation and Maintenance Data: For central dimming controls with remote-mounting dimmers to include in emergency, operation, and maintenance manuals.
4. Warranty: Special warranty specified in this Section.



- 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 47 CFR 15, Subparts A and B, for Class A digital devices.
  3. Comply with NFPA 70.
- F. Warranty
1. Manufacturer's standard form in which manufacturer agrees to repair or replace components of central dimming controls that fail in materials or workmanship within specified warranty period.
    - a. Failures include, but are not limited to, the following:
      - 1) Damage from transient voltage surges.
    - b. Warranty Period: Cost to repair or replace any parts for two years from date of Final Completion.
    - c. Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for eight years, that failed in service due to transient voltage surges.
- G. Software Service Agreement
1. Services in this Article may not be allowed for publicly funded projects.
  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. General System Requirements
1. Compatibility: Dimming control components shall be compatible with other elements of lighting fixtures, ballasts, transformers, and lighting controls.
  2. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state dimmers and control panels.
    - a. Alternative Line-Voltage Surge Suppression: Comply with requirements in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits" for Category A **OR** B, **as directed**, locations.
  3. Dimmers and Dimmer Modules: Comply with UL 508.
    - a. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.
    - b. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.
- B. System Description
1. Description: Microprocessor-based, solid-state controls consisting of control stations and a separately mounted dimmer cabinet.
    - a. Operation: Change variable dimmer settings of indicated number of zones simultaneously from one preset scene to another when a rocker switch **OR** pushbutton **OR** slider, **as directed**, is operated.
    - b. System control shall include master station(s), wall stations, and dimmer panels.
    - c. Each zone shall be configurable to control the following light sources:



- 1) Fluorescent lamps with electronic **OR** magnetic, **as directed**, ballasts.
  - 2) Line-voltage incandescent lamps.
  - 3) Low-voltage incandescent lamps.
  - 4) Cold cathode lamps.
  - 5) Non-dimmed loads.
  - 6) LED lamps.
- d. Control of each zone shall interface with controls for the following accessory functions:
- 1) Curtains and drapes.
  - 2) Blackout curtains.
  - 3) Projector screens.
  - 4) Motorized partitions.
  - 5) Manually positioned partitions.
- e. Memory: Retain preset scenes and fade settings through power failures for at least 90 days by retaining physical settings of controls or by an on-board, automatically recharged battery.
- C. Control Network
1. Dimmers shall receive signals from control stations that are linked to dimmer cabinet with a common network data cable.
  2. Functions of network control stations shall be set up at master station that include the number and arrangement of scene presets, zones, and fade times at wall stations.
    - a. Control Voltage: 24- or 10-V dc.
    - b. Comply with USITT AMX 192 **OR** USITT DMX 512, **as directed**, for data transmission.
- D. Master-Control Stations
1. Functions and Features:
    - a. Control adjustment of the lighting level for each scene of each zone, and adjustment of fade-time setting for each scene change from one preset scene to another. Controls shall use analog manual sliders **OR** digital rocker switches with LCD graphic display of light level, **as directed**.
    - b. Master channel shall raise and lower lighting level of all zones.
    - c. Fade rate for each scene shall be adjustable from zero to 60 seconds.
    - d. Fade override control for each scene.
    - e. Recall each preset scene and allow adjustment of zone controls associated with that scene.
    - f. Lockout switch to prevent changes when set.
    - g. On and off scene controls for non-dim channel contactors.
    - h. Emergency-control pushbutton to bypass all controls, turning all dimmers to full bright and turning on non-dim channel contactors.
    - i. Master on and off switch; off position enables housekeeping controls.
    - j. Housekeeping controls to turn on selected lighting fixtures for housekeeping functions.
    - k. Pushbuttons for accessory functions.
    - l. Enable and disable wall stations.
    - m. Communications link to other master stations.
    - n. Provide for connecting a portable computer to program the master station.
    - o. Rear-illuminate all scene-select buttons.
    - p. Show lighting-level setting and fade-rate setting graphically using LEDs or backlighted bar-graph indicator.
  2. Mounting: Single, flush wall box with manufacturer's standard faceplate with hinged transparent locking cover, **as directed**.
- E. Partitioned-Space Master-Control Station
1. Functions and Features:
    - a. Automatically combine and separate lighting and accessory function controls as spaces are configured with movable partitions; with controls for adjustment of the lighting level for



- each scene of each dimmer, and adjustment of fade-rate setting for each scene change from one preset scene to another.
- b. Master controls shall accommodate partitioning the space into six adjacent rooms.
  - c. Manual controls to set up six scenes for each room. Include wall stations in each room to control scenes.
  - d. Master channel to raise and lower the lighting level of all zones.
  - e. Adjustable fade rate for each scene from zero to 60 seconds.
  - f. Fade override control for each scene.
  - g. On and off scene controls for non-dim channel contactors.
  - h. Emergency-control pushbutton to bypass all controls, turning all dimmers to full bright and turning on non-dim channel contactors.
  - i. Master on and off switch; off position enables housekeeping controls.
  - j. Housekeeping controls to turn on selected lighting fixtures for housekeeping functions.
  - k. Pushbuttons for accessory functions.
  - l. Provide for connecting a portable computer to program the master station.
  - m. Rear-illuminate all scene-select buttons.
  - n. Show lighting-level setting and fade-rate setting graphically using LEDs or backlighted bar-graph indicator.
2. Custom Graphics. Include a graphical display of room configurations and the names for each. Indicate the current spaces configuration with LCD graphic or LED-illuminated indicators, and show which wall stations are active. Inactive wall stations shall be automatically deactivated.
  3. Mounting: Single, flush wall box with manufacturer's standard faceplate with hinged transparent locking cover, **as directed**.

#### F. Wall Stations

1. Functions and Features:
  - a. Wall stations shall function as a submaster to a master station, containing limited control of selected scenes of the master station.
  - b. Controls to adjust the lighting level of each dimmer for each scene, and the fade time setting for each scene change from one preset scene to another.
  - c. Numbered pushbuttons to select scenes.
  - d. Off switch to turn master station off. Operating the off switch at any remote station shall automatically turn on selected housekeeping lighting, **as directed**.
  - e. On switch turns all scenes of master station to full bright.
  - f. Pushbutton controls for accessory functions.
2. Mounting: Flush, wall box with manufacturer's standard faceplate.
3. Hand-held Cordless Control: Scene-select and accessory function pushbuttons using infrared **OR** radio-frequency, **as directed**, transmission.

#### G. Dimmer Cabinets

1. Factory wired, convection cooled without fans, with barriers to accommodate 120- and 277-V feeders and suitable to control designated lighting equipment or accessory functions.
2. Ambient Conditions:
  - a. Temperature: 60 to 95 deg F (15 to 35 deg C).
  - b. Relative Humidity: 10 to 90 percent, noncondensing.
  - c. Filtered air supply.
3. Dimmer Cabinet Assembly: NRTL listed and labeled.
4. Cabinet Type: Plug in, modular, and accepting dimmers of each specified type in any plug-in position.
  - a. Integrated Fault-Current Rating: 10,000-A RMS symmetrical.
5. Lighting Dimmers: Solid-state SCR dimmers.
  - a. Primary Protection: Magnetic or thermal-magnetic circuit breaker, also serving as the disconnecting means.
  - b. Dimmer response to control signal shall follow the "Square Law Dimming Curve" specified in IESNA's "IESNA Lighting Handbook."



- c. Dimming Range: 0 to 100 percent, full output voltage not less than 98 percent of line voltage.
  - d. Dimmed circuits shall be filtered to provide a minimum 350-mic.sec. current-rise time at a 90-degree conduction angle and 50 percent of rated dimmer capacity. Rate of current rise shall not exceed 30 mA/mic.sec., measured from 10 to 90 percent of load-current waveform.
  - e. Protect controls of each dimmer with a fuse and transient voltage surge suppression, **as directed**.
6. Non-dim modules shall include relays with contacts rated to switch 20-A tungsten-filament load at 120-V ac and 20-A electronic ballast load at 277-V ac.
  7. Accessory function control modules shall be compatible with requirement of the accessory being controlled.
  8. Digital Control Network:
    - a. Dimmers shall receive digital signals from digital network control stations that are linked to the dimmer cabinet with a common network data cable.
    - b. Functions of digital network control stations shall be set up at the dimmer cabinet's electronic controls that include indicated number and arrangement of scene presets, channels, and fade times.
  9. Emergency Power Transfer Switch: Comply with UL 1008; factory prewired and pretested to automatically transfer load circuits from normal to emergency power supply when normal supply fails.
    - a. Transfer from normal to emergency supply when normal-supply voltage drops to 55 percent or less.
    - b. Retransfer immediately to normal on failure of emergency supply and after an adjustable time-delay of 10 to 90 seconds on restoration of normal supply while emergency supply is available.
    - c. Integrated Fault-Current Rating: Same value as listed for the panel.
    - d. Test Switch: Simulate failure of normal supply to test controls associated with transfer scheme.
    - e. Fabricate and test dimmer boards to withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
- H. Portable Computer
1. Description: As recommended by master-control station manufacturer, to program master station and associated wall stations, and all interconnected master stations, **as directed**. Portable computer shall be laptop style with a battery runtime of at least two hours. Display shall be an 11-inch (280-mm) interactive-matrix LCD and shall have required hardware, firmware, and software to program specified control functions of master-control stations.
  2. Software shall be configured and customized by master-station manufacturer.
- I. Manual Switches And Plates
1. Switches: Modular, momentary pushbutton, low-voltage type.
    - a. Color: White unless otherwise indicated.
    - b. Integral Pilot Light: Indicate when circuit is on. Use where indicated.
    - c. Locator Light: Internal illumination.
    - d. Wall Plates: Comply with requirements in Division 26 Section "Wiring Devices" for materials, finish, and color. Use multigang plates if more than one switch is indicated at a location.
    - e. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.
- J. Conductors And Cables
1. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".



2. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 **OR** 22 **OR** 24, **as directed**, AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
3. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 **OR** 16 **OR** 18, **as directed**, AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
4. Unshielded, Twisted-Pair Data Cable: Category 5e **OR** 6, **as directed**. Comply with requirements in Division 27 Section "Communications Horizontal Cabling".

### 1.3 EXECUTION

#### A. Wiring Installation

1. Comply with NECA 1.
2. Wiring Method:
  - a. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables"
  - b. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Division 27 Section "Communications Horizontal Cabling".
  - c. Minimum conduit size shall be 1/2 inch (13 mm).
3. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
4. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
5. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
6. Install dimmer cabinets for each zone.

#### B. Identification

1. Comply with requirements in Division 26 Section "Identification For Electrical Systems" for identifying components and power and control wiring.
2. Label each dimmer module with a unique designation.
3. Label each scene control button with approved scene description.

#### C. 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. Continuity tests of circuits.
  - b. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
    - 1) Include testing of dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
  - c. Emergency Power Transfer: Test listed functions.
3. Remove and replace malfunctioning dimming control components and retest as specified above.
4. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
5. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

#### D. Demonstration



1. Engage a factory-authorized service representative to train **OR** Train, **as directed**, the Owner's maintenance personnel to adjust, operate, and maintain central dimming controls. Laptop portable computer shall be used in training, **as directed**.
2. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls".

END OF SECTION 26 09 23 00d



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## SECTION 26 09 23 00e - MODULAR DIMMING CONTROLS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for modular dimming controls. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Manual modular dimming controls.
  - b. Integrated, multipreset modular dimming controls.

#### C. Definitions

1. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.
2. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
3. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.
4. SCR: Silicon-controlled rectifier.
5. Zone: A fixture or group of fixtures controlled simultaneously as a single entity. Also known as a "channel."

#### D. Submittals

1. Product Data: For each type of product indicated.
  - a. For modular dimming controls; include elevation, dimensions, features, characteristics, ratings, and labels.
  - b. Device plates and plate color and material.
  - c. Ballasts and lamp combinations compatible with dimmers.
  - d. Wiring Diagrams: Power, signal, and control wiring.
2. Samples: For master and remote-control stations, and faceplates with factory-applied color finishes and technical features.

#### 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. General Dimming Device Requirements

1. Compatibility: Dimming control components shall be compatible with other elements of lighting fixtures, ballasts, transformers, and lighting controls.
2. Dimmers and Dimmer Modules: Comply with UL 508.
  - a. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.
  - b. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.



#### B. Manual Modular Multiscene Dimming Controls

1. Description: Factory-fabricated equipment providing manual modular dimming control consisting of a wall-box-mounted, master-scene controller and indicated number of wall-box zone stations. Controls and dimmers shall be integrated for mounting in one-, two-, or three-gang wall box under a single wall plate. Each zone station shall be adjustable to indicated number of scenes, which shall be recorded on the zone controller.
2. Operation: Automatically change variable dimmer settings of indicated number of zones simultaneously from one preset scene to another when a push button is operated.
3. Each manual modular multiscene dimming controller shall include a master control and remote controls.
4. Each zone shall be configurable to control the following:
  - a. Fluorescent lamps with electronic **OR** magnetic, **as directed**, ballasts.
  - b. Incandescent lamps.
  - c. Low-voltage incandescent lamps.
5. Memory: Retain preset scenes through power failures for at least seven days.
6. Device Plates: Style, material, and color shall comply with Division 26 Section "Wiring Devices".
7. Master-Scene Controller: Suitable for mounting in a single flush wall box.
  - a. Switches: Master off, group dim, group bright, and selectors for each scene.
  - b. LED indicator lights, one associated with each scene switch, and one for the master off switch.
8. Fluorescent Zone Dimmer: Suitable for operating lighting fixtures and ballasts specified in Division 26 Section "Interior Lighting", and arranged to dim number of scenes indicated for the master-scene controller. Scene selection is at the master-scene controller for setting light levels of each zone associated with scene.
  - a. Switch: Rocker **OR** Slider, **as directed**, style for setting the light level for each scene.
  - b. LED indicator lights, one associated with each scene.
  - c. Electrical Rating: 1000 **OR** 2000, **as directed**, VA, 120 V.
9. Incandescent Zone Dimmer: Suitable for operating incandescent lamps at line-voltage or low-voltage lamps connected to a transformer and arranged to dim number of scenes indicated for the master-scene controller. Scene selection shall be at the master-scene controller for setting light levels of each zone associated with scene.
  - a. Switch: Rocker **OR** Slider, **as directed**, style for setting the light level for each scene.
  - b. LED indicator lights, one associated with each scene.
  - c. Voltage Regulation: Dimmer shall maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent in RMS voltage.

#### C. Integrated, Multipreset Modular Dimming Controls

1. Indicate number of wall-box, remote-control stations.
2. Description: Factory-fabricated, microprocessor-based, solid-state controls providing manual dimming control consisting of a master station and multiple wall-box, remote-control stations.
3. Operation: Automatically changes variable dimmer settings of indicated number of zones simultaneously from one preset scene to another when a push button is operated.
4. Each zone shall be configurable to control the following:
  - a. Fluorescent lamps with electronic **OR** magnetic, **as directed**, ballasts.
  - b. Incandescent lamps.
  - c. Low-voltage incandescent lamps.
5. Memory: Retain preset scenes and fade settings through power failures by retaining physical settings of controls.
6. Master Station:
  - a. Contains control panel and multiple control and dimmer modules.
  - b. Controls and commands adjustment of each dimmer-zone setting for each scene change from one preset scene to another.
    - 1) Master zone raises and lowers lighting level.
    - 2) Adjustable fade rate for each scene from 1 to 60 seconds.
  - c. Rear-illuminated, scene-select buttons.



- d. Lighting-level setting and fade-rate setting shall be graphically shown using LEDs or backlighted bar-graph indicator.
- e. Mounting: Flush wall box with manufacturer's standard faceplate.
7. Remote-Control Stations:
  - a. Numbered push buttons to select scenes.
  - b. Off switch to turn master station off. Operating the off switch at any remote station shall automatically turn on selected housekeeping lighting, **as directed**.
  - c. On switch turns all scenes of master station to full bright.
  - d. Control Wiring: NFPA 70, Class 2.
  - e. Mounting: Single flush wall box with manufacturer's standard faceplate.
8. Infrared Remote-Control Station: Same functions as for standard remote-control station, except that functions are input by a hand-held infrared transmitter.
9. Dimmers: Modular, plug-in type, with circuit breaker to protect the dimmer and branch circuit.
  - a. Dimming Circuit: Two SCR dimmers, in inverse parallel configuration.
  - b. Dimming Curve: Modified "square law" as specified in IESNA's "IESNA Lighting Handbook"; control voltage is 0- to 10-V dc.
  - c. Dimming Range: 0 to 100 percent, full output voltage not less than 98 percent of line voltage.
  - d. Voltage Regulation: Dimmer shall maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent in RMS voltage.
  - e. Short-Circuit Rating: 10 kA for 120 V, 14 kA for 277 V.

#### D. Conductors And Cables

1. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
2. Class 2 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 **OR** 22 **OR** 24, **as directed**, AWG. Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

### 1.3 EXECUTION

#### A. Wiring Installation

1. Comply with NECA 1.
2. Wiring Method: Comply with requirements in Division 26 Section "Low-voltage Electrical Power Conductors And Cables". Minimum conduit size shall be 1/2 inch (13 mm).
3. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
4. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
5. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

#### B. Identification

1. Comply with requirements in Division 26 Section "Identification For Electrical Systems" for identifying components and power and control wiring.
2. Label each dimmer module with a unique designation.
3. Label each scene control button with approved scene description.

#### C. 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. Continuity tests of circuits.
  - b. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
    - 1) Include testing of modular dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
3. Remove and replace malfunctioning modular dimming control components and retest as specified above.
4. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
5. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

D. Demonstration

1. Engage a factory-authorized service representative to train **OR** Train, **as directed**, Owner's maintenance personnel to adjust, operate, and maintain modular dimming controls. Laptop portable computer shall be used in training, **as directed**.
2. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls".

END OF SECTION 26 09 23 00e



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 09 23 00	02 84 16 00	Removal of Fluorescent Light Ballasts/Capacitors and Fluorescent Light Tubes
26 09 23 00	02 84 16 00a	Interior Lighting
26 09 23 00	02 84 16 00b	Exterior Lighting



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## SECTION 26 11 13 00 - SECONDARY UNIT SUBSTATIONS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for secondary unit substations. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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 indoor and outdoor secondary unit substations, each consisting of the following:
  - a. Primary incoming section.
  - b. Transformer.
  - c. Secondary distribution section.

#### C. Definitions

1. NETA ATS: Acceptance Testing Specification.

#### D. Submittals

1. Product Data: Include rated capacities, furnished specialties, and accessories.
2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Time-Current Characteristic Curves: For overcurrent protective devices.
4. Primary Fuses: Submit recommendations and size calculations.
5. Manufacturer Seismic Qualification Certification: Submit certification that transformer assembly and components will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
6. Field quality-control test reports.
7. Operation and Maintenance Data: For secondary unit substations and accessories to include in emergency, operation, and maintenance manuals.

#### E. Quality Assurance

1. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Comply with IEEE C2.
3. Comply with IEEE C37.121.
4. Comply with NFPA 70.

#### F. Delivery, Storage, And Handling

1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.
2. Coordinate delivery of secondary unit substations to allow movement into designated space.
3. Store secondary unit substation components protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.
4. Handle secondary unit substation components according to manufacturer's written instructions. Use factory-installed lifting provisions.

#### G. Project Conditions

1. Service Conditions: IEEE C37.121, usual service conditions, except for the following:
  - a. Exposure to significant solar radiation.
  - b. Altitudes above 3300 feet (1000 m).



- c. Exposure to fumes, vapors, or dust.
- d. Exposure to explosive environments.
- e. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
- f. Exposure to seismic shock or to abnormal vibration, shock, or tilting.
- g. Exposure to excessively high or low temperatures.
- h. Unusual transportation or storage conditions.
- i. Unusual grounding resistance conditions.
- j. Unusual space limitations.

## 1.2 PRODUCTS

### A. Manufactured Units

1. Indoor Unit Arrangement: Single assembly **OR** Separate secondary distribution equipment connected with busway, **as directed**.
2. Outdoor Unit Arrangement: Single assembly **OR** Separate secondary distribution equipment connected with busway, **as directed**.
  - a. Weatherproof, listed for installation outdoors, complying with IEEE C37.20.1.
  - b. Aisleless Construction: Full-height doors in front of basic weatherproof equipment.
3. Enclosure Finish: Factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating **OR** Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface, **as directed**.

### B. Incoming Section

1. Primary Incoming Section: Terminal assembly with adequate space for incoming-cable terminations and surge arresters.
  - OR**
  - Transformer cover-mounted bushings.
  - OR**
  - Enclosed, air-interrupter, dual primary **OR** primary, **as directed**, switch.
    - a. Three pole, single throw, dead front, metal enclosed, with manual stored energy operator, with fuses mounted on a single frame **OR** without fuses, **as directed**, complying with IEEE C37.20.3.
    - b. Key interlocking system to prevent fuse access door from being opened unless switch is open. Additionally, interlock air-interrupter switch with transformer secondary main circuit breaker, preventing switch from being opened or closed unless secondary main circuit breaker is open.
    - c. Phase Barriers: Located between blades and fuses of each phase, designed for easy removal, allows visual inspection of switch components when barrier is in place.
    - d. Window: Permits viewing switch-blade positions when door is closed.
    - e. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.
    - f. Continuous-Current Rating: 600 A.
    - g. Short-Circuit Rating:
      - 1) Short-time momentary asymmetrical fault rating of 40 kA.
      - 2) 3-second symmetrical rating of 25-kA RMS.
      - 3) Fault close asymmetrical rating of 40 kA.
    - h. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading. Comply with the following:
      - 1) Current-limiting type, rated for not less than 50-kA RMS symmetrical current-interrupting capacity.
      - 2) Indicator integral with each fuse to show when it has blown.



- 3) Spares: Include three fuses in use and three spare fuses in storage clips in each switch.
  2. Surge Arresters: Comply with IEEE C62.11, Distribution class; metal-oxide-varistor type, with ratings as indicated, connected in each phase of incoming circuit and ahead of any disconnecting device.
- C. Liquid-Filled Transformer Section
1. Description: IEEE C57.12.00 and UL 1062, liquid-filled, 2-winding, secondary unit substation transformer.
  2. Insulating Liquid: Mineral oil complying with ASTM D 3487, Type II, and tested according to ASTM D 117.  
**OR**  
Insulating Liquid: Less flammable, edible-seed-oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.  
**OR**  
Insulating Liquid: Less flammable, dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.  
**OR**  
Insulating Liquid: Less flammable, silicone-based dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall have low toxicity and be nonhazardous.
  3. Insulation Temperature Rise: 65/55 deg C, based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C. Insulation system shall be rated to continuously allow an additional 12-percent kVA output, at 65 deg C temperature rise, without decreasing rated transformer life.  
**OR**  
Insulation Temperature Rise: 65 deg C, based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C.
  4. Basic Impulse Level: Comply with UL 1062.  
**OR**  
Basic Impulse Level: 60 **OR** 75 **OR** 95 **OR** 110, **as directed**, kV.
  5. Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps, 2 above and 2 below rated primary voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.  
**OR**  
Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps below rated primary voltage, with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
  6. Cooling System: Class OA, liquid cooled **OR** OA/FA, liquid cooled, and with forced-air rating **OR** OA/FFA, liquid cooled, and with provisions for future forced-air rating, **as directed**. Cooling systems shall include auxiliary cooling equipment, automatic controls, and status indicating lights.
  7. Sound level may not exceed 58 dB, without fans.
  8. Impedance: Percentage as directed.
  9. Accessories: Grounding pads, lifting lugs, and provisions for jacking under base. Transformers shall have a steel base and frame allowing use of pipe rollers in any direction, and an insulated, low-voltage, neutral bushing with removable ground strap. Include the following additional accessories:
    - a. Liquid-level gage.
    - b. Pressure-vacuum gage.
    - c. Liquid temperature indicator.
    - d. Drain and filter valves.
    - e. Pressure relief device.
- D. Dry-Type Transformer Section



1. Description: IEEE C57.12.01, IEEE C57.12.50 for dry-type transformers rated up to 500 kVA, IEEE C57.12.51 for dry-type transformers rated 501 kVA and larger, or IEEE C57.12.52 for sealed dry-type transformers rated 501 kVA and larger, NEMA ST 20, and dry-type, 2-winding, secondary unit substation transformer.
2. Enclosure: Indoor, ventilated **OR** Outdoor, ventilated **OR** Totally enclosed, nonventilated, **as directed**, cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 185 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.  
**OR**  
Enclosure: Indoor, ventilated **OR** Outdoor, ventilated **OR** Totally enclosed, nonventilated, **as directed**, vacuum-pressure, impregnated type and with insulation system rated at 220 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.
3. Cooling System: Class AA, air cooled **OR** AA/FA, air cooled with forced-air rating **OR** AA/FFA, air cooled with provisions for future forced-air rating, **as directed**, complying with IEEE C57.12.01.
  - a. Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm silencing relay.
  - b. Include mounting provision for fans.
4. Insulation Materials: IEEE C57.12.01, rated 220 deg C.
5. Insulation Temperature Rise: 80 **OR** 115 **OR** 150, **as directed**, deg C, maximum rise above 40 deg C.
6. Basic Impulse Level: 60 **OR** 75 **OR** 95 **OR** 110, **as directed**, kV.
7. Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps, 2 above and 2 below rated primary voltage.  
**OR**  
Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps below rated primary voltage.
8. Sound level may not exceed maximum dBA level **as directed**, without fans operating.
9. Impedance: Percentage **as directed**.
10. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

E. Secondary Distribution Section

1. Secondary Terminal Compartment: Bus bars mounted on standoff insulators **OR** duct flange for close coupling with busway, **as directed**.  
**OR**  
Secondary Distribution: Low-voltage switchgear as specified in Division 26 Section "Low-voltage Switchgear".  
**OR**  
Secondary Distribution: Low-voltage switchboard as specified in Division 26 Section "Switchboards".  
**OR**  
Secondary Distribution: Motor-control center as specified in Division 26 Section "Motor-control Centers".  
**OR**  
Distribution Panelboard: Panelboards as specified in Division 26 Section "Panelboards".
2. Network Protectors:
  - a. Rated for continuous service in an ambient temperature of up to 40 deg C, applied to 3-phase, 4-wire, solidly grounded wye secondary networks. Comply with IEEE C57.12.44.
  - b. Dead-front, drawout design with externally mounted fuses, using hand-cranked rail system. Relay and control panel located on a separate drawout module.
  - c. Protector Operator: Spring-close and/or stored-energy mechanism, rated to close on a 25,000 **OR** 40,000, **as directed**, RMS symmetrical load.
  - d. Control Voltage: Not more than 125 V.



- e. Control microprocessor-based, three-phase, tripping relay with features and functions as follows:
  - 1) Close protector if positive sequence power flows into the network. Adjustable closing range shall be from 0.5 to 3.5 V in phase difference between network and transformer voltages.
  - 2) Trip protector if there is a net, three-phase, reverse power flow through protector. Trip protectors shall be adjustable from 0.05 to 5 percent of continuous-current rating of current transformers within protector.
  - 3) Trip protector if there is a flow of reverse magnetizing current of its associated transformer.
  - 4) Field-adjustable relay parameters and watt or watt-var trip values.
- f. Protector shall not open under any fault on network side of protector.
- g. Current-limiting fuses shall have interrupting capacity of 150,000 A on network side of protector for protection against switchboard bus faults.
- h. Mechanical interlocks shall prevent racking in and racking out when protector is closed.
- i. Auxiliary contacts shall be remotely tripped and locked out by four-wire remote pilot devices.
- j. Network protectors shall have not less than two spare auxiliary dry contacts.
- k. Network Switchgear-Mounted Disconnect Switch: Supply each network-protector circuit with a switchgear-mounted fuse truck, with Class L fuses rated for 200-kA interrupting capacity, and key interlocked with each associated protector.  
**OR**  
Network Switchgear-Mounted Disconnect Switch: Supply each network-protector circuit with a switchgear-mounted main circuit breaker rated for fault current that can be delivered by the network transformers, less one. Use drawout type to provide a means of isolating the load side of each protector from the network bus.

F. Identification Devices

- 1. Compartment Nameplates: Engraved, laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification For Electrical Systems".

G. Source Quality Control

- 1. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90. Conduct switchgear and switchboard tests according to ANSI C37.51.  
**OR**  
Factory Tests: Perform the following factory-certified tests on each secondary unit substation:
  - a. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
  - b. Ratios on the rated voltage connection and on tap extreme connections.
  - c. Polarity and phase relation on the rated voltage connection.
  - d. No-load loss at rated voltage on the rated voltage connection.
  - e. Exciting current at rated voltage on the rated voltage connection.
  - f. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
  - g. Applied potential.
  - h. Induced potential.
  - i. Temperature Test: If a transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class FA rating.
    - 1) Temperature test is not required if a record of a temperature test on an essentially duplicate unit is available.
  - j. the Owner will witness all required factory tests. Notify the Owner at least 14 days before date of tests and indicate their approximate duration.



### 1.3 EXECUTION

#### A. Installation

1. Install secondary unit substations on concrete bases.
  - a. Anchor secondary unit substations to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Section "Hangers And Supports For Electrical Systems".
  - b. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit and 4 inches (100 mm) high.
  - c. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".
  - d. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
  - e. Install epoxy-coated anchor bolts for anchoring equipment to the concrete base.
  - f. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - g. Bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.
2. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

#### B. Identification

1. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification For Electrical Systems".
2. Operating Instructions: Frame printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of secondary unit substation.

#### C. Connections

1. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
2. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

#### D. Cleaning

1. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

#### E. Field Quality Control

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
2. Perform the following field tests and inspections and prepare test reports:
  - a. Perform each visual and mechanical inspection and electrical test according to NETA ATS. Certify compliance with test parameters.
  - b. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation tested at the specified value or less.
  - c. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
  - d. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
    - 1) Remove and replace malfunctioning units and retest as specified above.



F. Follow-Up Service

1. Voltage Monitoring and Adjusting: After Final Completion, if requested by the Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:
  - a. During a period of normal load cycles as evaluated by the Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
  - b. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
    - 1) Adjust transformer taps.
    - 2) Rebalance loads.
    - 3) Prepare written request for voltage adjustment by electric utility.
  - c. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
  - d. Report: Prepare a written report covering monitoring performed and corrective action taken.
2. Infrared Scanning: Perform as specified in Division 26 Section "Medium-voltage Switchgear".

END OF SECTION 26 11 13 00



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**SECTION 26 11 16 00 - SWITCHGEAR**

## 1.1 GENERAL

## A. Description Of Work

1. This specification covers the furnishing and installation of materials for switchgear. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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 metal-enclosed, low-voltage power circuit-breaker switchgear rated 1000 V and less for use in ac systems.

## C. Definitions

1. ATS: Acceptance Testing Service.
2. GFCI: Ground-fault circuit interrupter.

## D. Submittals

1. Product Data: For each type of switchgear, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
2. Shop Drawings: For each type of switchgear and related equipment.
  - a. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:
  - b. Wiring Diagrams: Power, signal, and control wiring.
3. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
4. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.
5. Manufacturer Seismic Qualification Certification: Submit certification that switchgear, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
6. Field quality-control test reports.
7. Updated mimic-bus diagram reflecting field changes after final switchgear load connections have been made, for record.
8. Operation and Maintenance Data: For switchgear and components to include in emergency, operation, and maintenance manuals. Include the following:
  - a. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  - b. Time-current curves, including selectable ranges for each type of overcurrent protective device.

## E. Quality Assurance

1. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
  - a. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.



2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Comply with NFPA 70.

F. Delivery, Storage, And Handling

1. Deliver switchgear in sections of lengths that can be moved past obstructions in delivery path.
2. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.
3. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

G. Project Conditions

1. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.
2. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service.
3. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
4. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
  - a. Ambient Temperature: Not exceeding 40 deg C.
  - b. Altitude: Not exceeding 6600 feet (2010 m).

## 1.2 PRODUCTS

A. Ratings

1. Nominal System Voltage: 480 V, 3 wire **OR** 480/277 V, 4 wire **OR** 240 V, 3 wire **OR** 208/120 V, 4 wire, **as directed**, 60 Hz.
2. Main-Bus Continuous: 4000 **OR** 3200 **OR** 2000 **OR** 1600, **as directed**, A.
3. Short-Time and Short-Circuit Current: Match rating of highest-rated circuit breaker in switchgear assembly.

B. Fabrication

1. Factory assembled and tested and complying with IEEE C37.20.1.
2. Indoor Enclosure Material: Steel.
3. Outdoor Enclosure Material: Galvanized steel.
4. Outdoor Enclosure Fabrication Requirements: Weatherproof; integral structural-steel base frame with factory-applied asphaltic undercoating; and each compartment equipped with the following features:
  - a. Structural design and anchorage adequate to resist loads imposed by 125-mph (200-km/h), **as directed**, wind.
  - b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation.
  - c. Louvers equipped with insect and rodent screen and filter; arranged to permit air circulation while excluding insects, rodents, and exterior dust.
  - d. Hinged front door with padlocking provisions.
  - e. Interior light with switch.
  - f. Weatherproof duplex receptacle.



- g. Common internal aisle of sufficient width to permit protective-device withdrawal, disassembly, and servicing in aisle.
  - h. Aisle access doors with outside padlocking provisions and interior panic latches.
  - i. Aisle space heaters operating at one-half or less of rated voltage, thermostatically controlled.
  - j. Vaporproof fluorescent aisle lights with low-temperature ballasts, controlled by wall switch at each entrance.
  - k. GFCI duplex receptacles, a minimum of two, located in aisle.
  - l. Aisle ventilation louvers equipped with insect and rodent screen and filter and arranged to permit air circulation while excluding insects, rodents, and exterior dust.
5. Finish: IEEE C37.20.1, manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.
6. Section barriers between main and tie circuit-breaker compartments shall be extended to rear of section.
7. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker.
8. Circuit-breaker compartments shall be equipped to house drawout-type circuit breakers and shall be fitted with hinged outer doors.
9. Fabricate enclosure with removable, hinged, rear cover panels to allow access to rear interior of switchgear.
10. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:
- a. Utility metering compartment that complies with utility company requirements.
  - b. Bus transition sections.
  - c. Incoming-line pull sections.
  - d. Hinged front panels for access to metering, accessory, and blank compartments.
  - e. Pull box on top of switchgear for extra room for pulling cable, with removable top, front, and side covers and ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.
    - 1) Set pull box back from front to clear circuit-breaker lifting mechanism.
    - 2) Bottom: Insulating, fire-resistant material with separate holes for cable drops into switchgear.
    - 3) Cable Supports: Arranged to ease cabling and adequate to support cables indicated, including those for future installation.
11. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.
- a. Main Phase Bus: Uniform capacity the entire length of assembly.
  - b. Neutral Bus: 50 **OR** 100, **as directed**, percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
  - c. Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
  - d. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.

**OR**

Phase- and Neutral-Bus Material: Silver- or tin-plated, high-strength, electrical-grade aluminum alloy, with copper or tin-plated aluminum circuit-breaker line connections.

**OR**

Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.
  - e. Use silver-plated copper or tin-plated aluminum for connecting circuit-breaker line to aluminum bus.
  - f. Use copper for connecting circuit-breaker line to copper bus.
  - g. Contact Surfaces of Buses: Silver plated.
  - h. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.



- i. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size 1/4 by 2 inches (6 by 50 mm).
- j. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.
- k. Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors. Neutral-bus extensions for busway feeders are braced.
- l. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch (6-by-50-mm) copper bus, arranged to connect neutral bus to ground bus.
- m. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
- n. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.
  - 1) Sprayed Insulation Thickness: 3 mils (0.08 mm), minimum.
  - 2) Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

### C. Components

1. Instrument Transformers: Comply with IEEE C57.13.
  - a. Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
  - b. Current Transformers: Ratios as indicated; burden and accuracy class suitable for connected relays, meters, and instruments.
2. Multifunction Digital-Metering Monitor: UL-listed or -recognized, microprocessor-based unit suitable for three- or four-wire systems and with the following features:
  - a. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
  - b. Switch-selectable digital display of the following:
    - 1) Phase Currents, Each Phase: Plus or minus 1 percent.
    - 2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
    - 3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
    - 4) Three-Phase Real Power: Plus or minus 2 percent.
    - 5) Three-Phase Reactive Power: Plus or minus 2 percent.
    - 6) Power Factor: Plus or minus 2 percent.
    - 7) Frequency: Plus or minus 0.5 percent.
    - 8) Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
    - 9) Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
  - c. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
3. Analog Instruments: Rectangular, 4-1/2-inch (115-mm) square, accurate within 1 percent, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment, complying with ANSI C39.1.
  - a. Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
  - b. Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase and phase-to-neutral voltages.
  - c. Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
  - d. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
  - e. Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
  - f. Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, 3 phase, 3 wire; with 3 elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.



- g. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.
    - 1) Operation: Meter counts and records a succession of pulses entering two channels.
    - 2) Housing: Drawout, back-connected case arranged for semiflush mounting.
  - 4. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.
  - 5. Surge Arresters: Distribution class, metal-oxide-varistor type. Comply with IEEE C62.11 and NEMA LA 1.
    - a. Install in cable termination compartments and connect in each phase of circuit.
    - b. Coordinate rating with circuit voltage.
  - 6. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.
  - 7. Fungus Proofing: Permanent fungicidal treatment for switchgear interior, including instruments and instrument transformers.
  - 8. Control Power Supply: Control power transformer supplying 120-V control circuits through secondary disconnect devices. Include the following features:
    - a. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
    - b. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.
      - 1) Secondary windings connected through a relay or relays to control bus to effect an automatic transfer scheme.
      - 2) Secondary windings connected through an internal automatic transfer switch to switchgear control power bus.
    - c. Control Power Fuses: Primary and secondary fuses with current-limiting and overload protection.
    - d. Fuses are specified in Division 26 Section "Fuses".
  - 9. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
    - a. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
    - b. Conductors sized according to NFPA 70 for duty required.
- D. Circuit Breakers
- 1. Description: Comply with IEEE C37.13.
  - 2. Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.
  - 3. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
    - a. Normal Closing Speed: Independent of both control and operator.
    - b. Slow Closing Speed: Optional with operator for inspection and adjustment.
    - c. Stored-Energy Mechanism: Manually charged **OR** Electrically charged, with optional manual charging, **as directed**.
    - d. Operation counter.
  - 4. Trip Devices: Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:
    - a. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
    - b. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.
    - c. Field-adjustable, time-current characteristics.
    - d. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.
    - e. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
    - f. Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable  $I^2t$  operation.



- g. Pickup Points: Five minimum, for instantaneous-trip functions.
  - h. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:
    - 1) Three-wire circuit or system.
    - 2) Four-wire circuit or system.
    - 3) Four-wire, double-ended substation.
  - i. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
5. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.
  6. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:
    - a. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
    - b. Circuit-Breaker Positioning: An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open. Status for connection devices for different positions includes the following:
      - 1) Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
      - 2) Disconnected Position: Primary and secondary devices and ground contact disengaged.
  7. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.
  8. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.
  9. Operating Handle: One for each circuit breaker capable of manual operation.
  10. Electric Close Button: One for each electrically operated circuit breaker.
  11. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.
  12. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key-interlock devices is indicated.
  13. Undervoltage Trip Devices: Instantaneous, with adjustable pickup voltage **OR** Adjustable time-delay and pickup voltage, **as directed**.
  14. Shunt-Trip Devices: Where indicated.
  15. Fused Circuit Breakers: Circuit breaker and fuse combinations complying with requirements for circuit breakers and trip devices and with the following:
    - a. Fuses: NEMA FU 1, Class L current limiting, sized to coordinate with and protect associated circuit breaker.
    - b. Circuit Breakers with Frame Size 1600 A and Smaller: Fuses on line side of associated circuit breaker, on a common drawout mounting, arranged so fuses are accessible only when circuit breaker is in disconnected position.
    - c. Circuit Breakers with Frame Sizes More Than 1600 A: Fuses and circuit breakers may be installed in separate compartments on separate drawout mountings. Fuse drawout element is interlocked with associated power circuit breaker to prevent drawing out fuse element unless circuit breaker is in open position.
    - d. Open-Fuse Trip Device: Positive means of tripping and holding circuit breaker in open position when a fuse opens. Open-fuse status is indicated at front of circuit breaker or fuse drawout element.



16. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

E. Accessories

1. Accessory Set: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.
  - a. Racking handle to manually move circuit breaker between connected and disconnected positions.
  - b. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
  - c. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
2. Circuit-Breaker Removal Apparatus: Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments.
3. Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.
4. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.
5. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

F. Identification

1. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
  - a. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
  - b. Medium: Painted graphics, as selected by Architect.
  - c. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.
2. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:
  - a. Frame size of each circuit breaker.
  - b. Trip rating for each circuit breaker.
  - c. Conduit and wire size for each feeder.

### 1.3 EXECUTION

A. Installation

1. Comply with applicable portions of NECA 400.
2. Anchor switchgear assembly to 4-inch (100-mm), channel-iron floor sill embedded in floor **OR** concrete base, **as directed**, and attach by bolting.
  - a. Sills: Select to suit switchgear; level and grout flush into floor **OR** concrete base, **as directed**.
  - b. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Hangers And Supports For Electrical Systems" for seismic-restraint requirements.
  - c. 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".
3. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.



- B. Identification
1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification For Electrical Systems".
  2. Diagram and Instructions:
    - a. Frame and mount under clear acrylic plastic on the front of switchgear.
      - 1) Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
      - 2) System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.
    - b. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.
- C. Connections
1. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
  2. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
- D. Field Quality Control
1. Prepare for acceptance tests as follows:
    - a. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
    - b. Test continuity of each circuit.
  2. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
    - a. Inspect switchgear installation, including wiring, components, connections, and equipment. Test and adjust components and equipment.
    - b. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 22.
    - c. Complete installation and startup checks according to manufacturer's written instructions.
    - d. Assist in field testing of equipment including pretesting and adjusting of equipment and components.
    - e. Report results in writing.
  3. Testing Agency: Engage a qualified independent testing and inspecting agency to perform 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. Perform NETA tests and inspections for each of the following NETA categories:
      - 1) Switchgear.
      - 2) Circuit breakers.
      - 3) Protective relays.
      - 4) Instrument transformers.
      - 5) Metering and instrumentation.
      - 6) Ground-fault systems.
      - 7) Battery systems.
      - 8) Surge arresters.
      - 9) Capacitors.
    - b. Remove and replace malfunctioning units and retest as specified above.
  4. Infrared Scanning: After Final Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.
    - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Final Completion.



- b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - c. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- E. Adjusting
- 1. Set field-adjustable, protective-relay trip characteristics according to results in Division 26 Section "Overcurrent Protective Device Coordination Study".
  - 2. Set field-adjustable, protective-relay trip characteristics.
- F. Cleaning
- 1. On completion of installation, inspect interior and exterior of switchgear. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.
- G. Protection
- 1. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

END OF SECTION 26 11 16 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 11 16 00	26 11 13 00	Secondary Unit Substations

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## SECTION 26 12 13 00 - MEDIUM-VOLTAGE TRANSFORMERS

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. This Section includes the following types of transformers with medium-voltage primaries:
  - a. Liquid-filled distribution and power transformers.
  - b. Dry-type distribution and power transformers.
  - c. Pad-mounted, liquid-filled transformers.

#### C. Definitions

1. NETA ATS: Acceptance Testing Specification.

#### D. Submittals

1. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.
2. Shop Drawings: Diagram power signal and control wiring.
3. Manufacturer Seismic Qualification Certification: Submit certification that transformer assembly and components will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
4. Field quality-control test reports.
5. Follow-up service reports.
6. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

#### E. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Comply with IEEE C2.
3. Comply with ANSI C57.12.10, ANSI C57.12.28, IEEE C57.12.70, and IEEE C57.12.80.
4. Comply with NFPA 70.

#### F. Delivery, Storage, And Handling

1. Store transformers protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

#### G. Project Conditions

1. Service Conditions: IEEE C37.121, usual service conditions except for the following:
  - a. Exposure to significant solar radiation.
  - b. Altitudes above 3300 feet (1000 m).
  - c. Exposure to fumes, vapors, or dust.
  - d. Exposure to explosive environments.
  - e. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
  - f. Exposure to seismic shock or to abnormal vibration, shock, or tilting.
  - g. Exposure to excessively high or low temperatures.



- h. Unusual transportation or storage conditions.
- i. Unusual grounding-resistance conditions.
- j. Unusual space limitations.

## 1.2 PRODUCTS

### A. Liquid-Filled Distribution And Power Transformers

1. Description: IEEE C57.12.00 and UL 1062, liquid-filled, 2-winding transformers.
2. Insulating Liquid: Mineral oil, complying with ASTM D 3487, Type II, and tested according to ASTM D 117.  
**OR**  
 Insulating Liquid: Less flammable, edible-seed-oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.  
**OR**  
 Insulating Liquid: Less flammable, dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.  
**OR**  
 Insulating Liquid: Less flammable, silicone-based dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall have low toxicity and be nonhazardous.
3. Insulation Temperature Rise: 65/55 deg C, based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C. Insulation system shall be rated to continuously allow an additional 12 percent kilovolt-ampere output, at 65 deg C temperature rise, without decreasing rated transformer life.  
**OR**  
 Insulation Temperature Rise: 65 deg C, based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C.
4. Basic Impulse Level: Comply with UL 1062.  
**OR**  
 Basic Impulse Level: 60 **OR** 75 **OR** 95 **OR** 110, **as directed** kV.
5. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated primary voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.  
**OR**  
 Full-Capacity Voltage Taps: Four nominal 2.5 percent taps below rated primary voltage, with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
6. Cooling System: Class OA, self-cooled **OR** OA/FA, self-cooled, and with forced-air-cooled rating **OR** OA/FFA, self-cooled, and with provisions for future forced-air-cooled rating, **as directed**. Cooling systems shall include auxiliary cooling equipment, automatic controls, and status indicating lights.
7. Sound level may not exceed sound levels listed in NEMA TR 1, without fans operating.
8. Accessories: Grounding pads, lifting lugs, and provisions for jacking under base. Transformers shall have a steel base and frame allowing use of pipe rollers in any direction, and an insulated, low-voltage, neutral bushing with removable ground strap. Include the following additional accessories:
  - a. Liquid-level gage.
  - b. Pressure-vacuum gage.
  - c. Liquid temperature indicator.
  - d. Drain and filter valves.
  - e. Pressure relief device.

**B. Dry-Type Distribution And Power Transformers**

1. Description: NEMA ST 20, IEEE C57.12.01, ANSI C57.12.50 for dry-type transformers rated up to 500 kVA, ANSI C57.12.51 for dry-type transformers rated 501 kVA and larger, or ANSI C57.12.52 for sealed dry-type transformers rated 501 kVA and larger, UL 1562 listed and labeled, dry-type, 2-winding transformers.
  - a. Indoor, ventilated **OR** Outdoor, ventilated **OR** Totally enclosed, nonventilated, **as directed**, cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 185 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.
  - b. Indoor, ventilated **OR** Outdoor, ventilated **OR** Totally enclosed, nonventilated, **as directed**, vacuum-pressure impregnated and with insulation system rated at 220 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.
2. Primary Connection: Air terminal compartment with removable **OR** hinged, **as directed**, door. Tin-plated copper bar for incoming line termination, predrilled to accept terminals for indicated conductors.  
**OR**  
Primary Connection: Transition terminal compartment with connection pattern to match switchgear.
3. Secondary Connection: Air terminal compartment with removable **OR** hinged, **as directed**, door. Tin-plated copper bar for incoming line termination, predrilled to accept terminals for indicated conductors.  
**OR**  
Secondary Connection: Transition terminal compartment with connection pattern to match switchgear **OR** bus duct, **as directed**.
4. Insulation Materials: IEEE C57.12.01, rated at 220 deg C.
5. Insulation Temperature Rise: 80 **OR** 115 **OR** 150, **as directed**, deg C, maximum rise above 40 deg C.
6. Basic Impulse Level: 60 **OR** 75 **OR** 95 **OR** 110, **as directed**, kV.
7. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated primary voltage.  
**OR**  
Full-Capacity Voltage Taps: Four nominal 2.5 percent taps below rated primary voltage.
8. Cooling System: Class AA, self-cooled **OR** AA/FA, self-cooled, and with forced-air-cooled rating **OR** AA/FFA, self-cooled, and with provisions for future forced-air-cooled rating, **as directed**, complying with IEEE C57.12.01.
  - a. Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm silencing relay.
  - b. Include mounting provision for fans.
9. Sound level may not exceed sound levels listed in NEMA TR 1, without fans operating.
10. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

**C. Pad-Mounted, Liquid-Filled Transformers**

1. Description: ANSI C57.12.13, ANSI C57.12.26 for pad-mounted transformers with dead-front, separable, insulated, high-voltage, load-break cable connectors, IEEE C57.12.00 IEEE C57.12.22 for pad-mounted transformers with live-front high-voltage bushings pad-mounted, 2-winding transformers. Stainless-steel tank base and cabinet, **OR** cabinet, and sills, **as directed**.
2. Insulating Liquid: Mineral oil, complying with ASTM D 3487, Type II, and tested according to ASTM D 117.  
**OR**  
Insulating Liquid: Less flammable, edible-seed-oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.

**OR**

Insulating Liquid: Less flammable, dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.

**OR**

Insulating Liquid: Less flammable, silicone-based dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall have low toxicity and be nonhazardous.

3. Insulation Temperature Rise: 55 **OR** 65, **as directed**, deg C when operated at rated kVA output in a 40 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C without loss of service life expectancy.
4. Basic Impulse Level: 30 **OR** 60 **OR** 95, **as directed**, kV.
5. Full-Capacity Voltage Taps: Four 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
6. High-Voltage Switch: 200 **OR** 300 **OR** 400, **as directed**, A, make-and-latch rating of 10-kA RMS, symmetrical, arranged for radial feed with 3-phase, 2-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.
 

**OR**

High-Voltage Switch: 200 **OR** 300 **OR** 400, **as directed**, A, make-and-latch rating of 10-kA RMS, symmetrical, arranged for loop feed with 3-phase, 4-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.
7. Primary Fuses: 150-kV fuse assembly with fuses complying with IEEE C37.47. Rating of current-limiting fuses shall be 50-kA RMS at specified system voltage.
  - a. Current-limiting type in dry-fuse holder wells, mechanically interlocked with liquid-immersed switch in transformer tank to prevent disconnect under load.
  - b. Internal liquid-immersed cartridge fuses.
  - c. Bay-O-Net liquid-immersed fuses that are externally replaceable without opening transformer tank.
  - d. Bay-O-Net liquid-immersed fuses in series with liquid-immersed current-limiting fuses. Bay-O-Net fuses shall be externally replaceable without opening transformer tank.
  - e. Bay-O-Net liquid-immersed current-limiting fuses that are externally replaceable without opening transformer tank.
8. Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1; support from tank wall within high-voltage compartment. Transformers shall have three arresters for radial-feed **OR** three arresters for loop-feed **OR** six arresters for loop-feed, **as directed**, circuits.
9. High-Voltage Terminations and Equipment: Live front with externally clamped porcelain bushings and cable connectors suitable for terminating primary cable.
 

**OR**

High-Voltage Terminations and Equipment: Dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:

  - a. Bushing-Well Inserts: One for each high-voltage bushing well.
  - b. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units.
  - c. Parking Stands: One for each high-voltage bushing well.
  - d. Portable Insulated Bushings: Arranged for parking insulated, high-voltage, load-break cable terminators; one for each primary feeder conductor terminating at transformer.
10. Accessories:
  - a. Drain Valve: 1 inch (25 mm), with sampling device.
  - b. Dial-type thermometer.
  - c. Liquid-level gage.
  - d. Pressure-vacuum gage.
  - e. Pressure Relief Device: Self-sealing with an indicator.
  - f. Mounting provisions for low-voltage current transformers.



- g. Mounting provisions for low-voltage potential transformers.
- h. Busway terminal connection at low-voltage compartment.
- i. Alarm contacts for gages and thermometer listed above.

D. Identification Devices

- 1. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification For Electrical Systems".

E. Source Quality Control

- 1. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to ANSI C57.12.50 for ventilated dry-type distribution transformers 1 to 500 kVA, single phase, and 15 to 500 kVA, 3 phase, with high voltage 601 to 34,500 V and low voltage 208Y/120 to 4160 V; ANSI C57.12.51 for ventilated dry-type power transformers 501 kVA and larger, 3 phase, with high voltage 601 to 34,500 V and low voltage 208Y/120 to 4160 V; IEEE C57.12.90 for liquid-filled transformers; and IEEE C57.12.91 for dry-type distribution and power transformers.
- 2. Factory Tests: Perform the following factory-certified tests on each transformer:
  - a. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
  - b. Ratios on rated-voltage connection and on tap extreme connections.
  - c. Polarity and phase relation on rated-voltage connection.
  - d. No-load loss at rated voltage on rated-voltage connection.
  - e. Excitation current at rated voltage on rated-voltage connection.
  - f. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
  - g. Applied potential.
  - h. Induced potential.
  - i. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class OA/FA or Class AA/FA rating.
    - 1) Temperature test is not required if record of temperature test on an essentially duplicate unit is available.

### 1.3 EXECUTION

A. Installation

- 1. Install transformers on concrete bases.
  - a. Anchor transformers to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Section "Hangers And Supports For Electrical Systems".
  - b. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit and 4 inches (100 mm) high.
  - c. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".
  - d. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
  - e. Install epoxy-coated anchor bolts, for supported equipment, that extend through concrete base and anchor into structural concrete floor.
  - f. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - g. Tack-weld or bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.



2. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- B. Identification
1. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification For Electrical Systems", **as directed**.
- C. Connections
1. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
  2. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
- D. Field Quality Control
1. Perform the following field tests and inspections and prepare test reports:
    - a. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
    - b. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
    - c. Perform visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
    - d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  2. Remove and replace malfunctioning units and retest as specified above.
  3. Test Reports: Prepare written reports 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 actions taken to achieve compliance with requirements.
- E. Follow-Up Service
1. Voltage Monitoring and Adjusting: If requested by the Owner, perform the following voltage monitoring after Final Completion but not more than six months after Final Acceptance:
    - a. During a period of normal load cycles as evaluated by the Owner, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
    - b. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:
      - 1) Adjust transformer taps.
      - 2) Prepare written request for voltage adjustment by electric utility.
    - c. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.
    - d. Report: Prepare written report covering monitoring and corrective actions performed.
  2. Infrared Scanning: Perform as specified in Division 26 Section "Medium-voltage Switchgear".

END OF SECTION 26 12 13 00



## SECTION 26 12 13 00a - LOW-VOLTAGE TRANSFORMERS

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
  - a. Distribution transformers.
  - b. Buck-boost transformers.

#### C. Submittals

1. Product Data: For each product indicated.
2. Shop Drawings: Indicate dimensions and weights.
  - a. Wiring Diagrams: Power, signal, and control wiring.
3. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
4. Field quality-control test reports.
5. 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 IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

#### E. Delivery, Storage, And Handling

1. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

### 1.2 PRODUCTS

#### A. General Transformer Requirements

1. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
2. Cores: Grain-oriented, non-aging silicon steel.
3. Coils: Continuous windings without splices except for taps.
  - a. Internal Coil Connections: Brazed or pressure type.
  - b. Coil Material: Aluminum **OR** Copper, **as directed**.

#### B. Distribution Transformers

1. Comply with NEMA ST 20, and list and label as complying with UL 1561.
2. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
3. Cores: One leg per phase.
4. Enclosure: Ventiladed **OR** Totally enclosed, nonventilated, **as directed**, NEMA 250, Type 2.



- a. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
5. Enclosure: Ventilated **OR** Totally enclosed, nonventilated, **as directed**, NEMA 250, Type 3R **OR** Type 4X, stainless steel, **as directed**.
  - a. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
6. Transformer Enclosure Finish: Comply with NEMA 250.
  - a. Finish Color: Gray **OR** ANSI 49 gray **OR** ANSI 61 gray, **as directed**.
7. Taps for Transformers Smaller Than 3 kVA: None **OR** One 5 percent tap above normal full capacity, **as directed**.
8. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity **OR** Two 5 percent taps below rated voltage, **as directed**.
9. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity **OR** Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity, **as directed**.
10. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 **OR** 115 **OR** 80, **as directed**, deg C rise above 40 deg C ambient temperature.
11. Energy Efficiency for Transformers Rated 15 kVA and Larger:
  - a. Complying with NEMA TP 1, Class 1 efficiency levels.
  - b. Tested according to NEMA TP 2.
12. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
  - a. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
  - b. Indicate value of K-factor on transformer nameplate.
13. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
14. Wall Brackets: Manufacturer's standard brackets.
15. Fungus Proofing: Permanent fungicidal treatment for coil and core.
16. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

#### C. Buck-Boost Transformers

1. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.
2. Enclosure: Ventilated, NEMA 250, Type 2.
  - a. Finish Color: Gray **OR** ANSI 49 gray **OR** ANSI 61 gray, **as directed**.

#### D. Identification Devices

1. Nameplates: Engraved, laminated-plastic or metal nameplate. Nameplates are specified in Division 26 Section "Identification For Electrical Systems".

### 1.3 EXECUTION

#### A. Installation

1. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
  - a. Brace wall-mounting transformers as specified in Division 26 Section "Hangers And Supports For Electrical Systems".
2. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, **as directed**, and requirements in Division 26 Section "Hangers And Supports For Electrical Systems".

#### B. Field Quality Control



1. Perform tests and inspections.
  2. Tests and Inspections:
    - a. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
    - b. Infrared Scanning: Two months after Final Completion, perform an infrared scan of transformer connections.
      - 1) Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
      - 2) Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Final Completion.
      - 3) Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- C. Adjusting
1. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
  2. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
  3. Output Settings Report: Prepare a written report recording output voltages and tap settings.
- D. Cleaning
1. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 12 13 00a



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 12 13 00	02 84 33 00	Overhead Electrical Distribution
26 12 16 00	26 12 13 00	Medium-Voltage Transformers
26 12 16 00	26 12 13 00a	Low-Voltage Transformers
26 12 19 00	26 12 13 00	Medium-Voltage Transformers
26 12 19 00	26 12 13 00a	Low-Voltage Transformers
26 13 16 00	26 11 13 00	Secondary Unit Substations
26 13 19 00	26 11 13 00	Secondary Unit Substations
26 18 16 00	26 11 16 00	Switchgear
26 21 13 00	26 05 13 00	Conductors And Cables
26 21 13 00	26 05 13 00a	Undercarpet Cables
26 21 13 00	26 05 13 00b	Medium-Voltage Cables
26 21 13 00	02 84 33 00	Overhead Electrical Distribution
26 22 13 00	26 12 13 00	Medium-Voltage Transformers
26 22 13 00	02 84 33 00	Overhead Electrical Distribution
26 22 13 00	26 12 13 00a	Low-Voltage Transformers



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**SECTION 26 24 13 00 - ELECTRICITY METERING****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for electricity metering. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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 equipment for electricity metering by utility company and electricity metering by the Owner.

**C. Definitions**

1. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.
2. PC: Personal computer.

**D. Submittals**

1. Product Data: For each type of product indicated.
2. Shop Drawings: For electricity-metering equipment.
  - a. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.
3. Field quality-control reports.
4. Operation and Maintenance Data. Include the following:
  - a. Application and operating software documentation.
  - b. Software licenses.
  - c. Software service agreement.
  - d. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

**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. Receive, store, and handle modular meter center according to NECA 400.

**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.

**H. Coordination**

1. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:



- a. Comply with requirements of utilities providing electrical power services.
  - b. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.
- I. Software Service Agreement (May Not Be Allowed For Publicly Funded Projects)
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 its computer equipment if necessary.

## 1.2 PRODUCTS

- A. Equipment For Electricity Metering By Utility Company
1. Meters will be furnished by utility company.
  2. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.
  3. Meter Sockets: Comply with requirements of electrical-power utility company.
- OR**
- Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.
4. Modular Meter Center: Factory-coordinated assembly of a main service terminal box with lugs only **OR** disconnect device, **as directed**, wireways, tenant meter socket modules, and tenant feeder circuit breakers arranged in adjacent vertical sections. Assembly shall be complete with interconnecting buses and other features as specified below.
    - a. Comply with requirements of utility company for meter center.
    - b. Housing: NEMA 250, Type 1 **OR** Type 3R, **as directed**, enclosure.
    - c. Minimum Short-Circuit Rating: 22,000 **OR** 42,000 **OR** 65,000 **OR** 100,000, **as directed**, A symmetrical at rated voltage.
    - d. Main Disconnect Device: Circuit breaker, series-combination rated for use with downstream feeder and branch circuit breakers.
 

**OR**

 Main Disconnect Device: Fusible switch, series-combination rated by circuit-breaker manufacturer to protect downstream feeder and branch circuit breakers.
    - e. Tenant Feeder Circuit Breakers: Series-combination-rated molded-case units, rated to protect circuit breakers in downstream tenant and to house loadcenters and panelboards that have 10,000-A interrupting capacity.
      - 1) Identification: Complying with requirements in Division 26 Section "Identification For Electrical Systems" with legend identifying tenant's address.
      - 2) Physical Protection: Tamper resistant, with hasp for padlock.
    - f. Meter Socket: Rating coordinated with indicated tenant feeder circuit rating.
    - g. Surge Protection: For main disconnect device, comply with requirements in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits".
- B. Equipment For Electricity Metering By the Owner
1. General Requirements for the Owner's Meters:
    - a. Comply with UL 1244.
    - b. Meters used for billing shall have an accuracy of 0.2 **OR** 0.5 **OR** 1.0, **as directed**, percent of reading, complying with requirements in ANSI C12.20.
    - c. Meters shall be certified by California Type Evaluation Program, **as directed**, as complying with Title 4, California Code of Regulations, Article 2.2, **as directed**.
    - d. Enclosure: NEMA 250, Type 1 **OR** Type 3R, **as directed**, minimum, with hasp for padlocking or sealing.



- e. Identification: Comply with requirements in Division 26 Section "Identification For Electrical Systems".
  - f. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
  - g. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
    - 1) Type: Split **OR** Split and solid, **as directed**, core.
  - h. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.
  - i. Building Automation System (BAS) Interface: One digital KY pulse to a user-definable increment of energy measurement. Match signal to BAS input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.
2. Kilowatt-hour Meter: Electronic single **OR** three **OR** single- and three, **as directed**, -phase meters, measuring electricity used.
    - a. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
    - b. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kilowatt-hours and current kilowatt load. Retain accumulated kilowatt-hour in a nonvolatile memory, until reset.  
**OR**  
Display: Digital electromechanical counter, indicating accumulative kilowatt-hours.
  3. Kilowatt-hour/Demand Meter: Electronic single **OR** three **OR** single- and three, **as directed**, -phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.
    - a. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
    - b. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kilowatt-hours, current time and date, current demand, and historic peak demand, and time and date of historic peak demand. Retain accumulated kilowatt-hour and historic peak demand in a nonvolatile memory, until reset.
  4. Data Transmission Cable: Transmit KY pulse data over Class 1 control-circuit conductors in raceway. Comply with Division 26 Section "Control-voltage Electrical Power Cables".
  5. Software: PC based, a product of meter manufacturer, suitable for calculation of utility cost allocation and billing, **as directed**.
    - a. Utility Cost Allocation: Automatically import energy-usage records to allocate energy costs for the following:
      - 1) At least 15 departments.
      - 2) At least 30 tenants.
      - 3) At least five processes.
      - 4) At least five buildings.
    - b. Tenant or Activity Billing Software: Automatically import energy-usage records to automatically compute and prepare tenant bills **OR** activity demand and energy-use statements, **as directed**, based on metering of energy use and peak demand, **as directed**. Maintain separate directory for each tenant's historical billing information. Prepare summary reports in user-defined formats and time intervals.

### 1.3 EXECUTION

#### A. Installation

1. Comply with equipment installation requirements in NECA 1.
2. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
3. Install modular meter center according to NECA 400 switchboard installation requirements.



B. Identification

1. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".
  - a. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
  - b. Equipment Identification Labels: Adhesive film labels with clear protective overlay. For residential meters, provide an additional card holder suitable for printed, weather-resistant card **OR** typewritten card, **as directed**, with occupant's name.

C. 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. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
  - b. Turn off circuits supplied by metered feeder and secure them in off condition.
  - c. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
  - d. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
3. Electricity metering will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

END OF SECTION 26 24 13 00



## SECTION 26 24 13 00a - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for enclosed switches and circuit breakers. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Fusible switches.
  - b. Nonfusible switches.
  - c. Receptacle switches.
  - d. Shunt trip switches.
  - e. Molded-case circuit breakers (MCCBs).
  - f. Molded-case switches.
  - g. Enclosures.

#### C. Definitions

1. NC: Normally closed.
2. NO: Normally open.
3. SPDT: Single pole, double throw.

#### D. Performance Requirements

1. Seismic Performance: Enclosed switches and circuit breakers 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," **as directed**.

#### E. Submittals

1. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.
2. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
  - a. Wiring Diagrams: For power, signal, and control wiring.
3. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
4. Field quality-control reports.
5. Operation and maintenance data.

#### F. Quality Assurance

1. 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.
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.

#### G. Project Conditions

1. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:



- a. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
- b. Altitude: Not exceeding 6600 feet (2010 m).
2. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - a. Notify the Owner no fewer than seven days in advance of proposed interruption of electric service.
  - b. Indicate method of providing temporary electric service.
  - c. Do not proceed with interruption of electric service without the Owner's written permission.
  - d. Comply with NFPA 70E.

## 1.2 PRODUCTS

### A. Fusible Switches

1. Type GD, General Duty, Single Throw, 240-V ac, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with cartridge **OR** plug, **as directed**, fuse interiors to accommodate specified **OR** indicated, **as directed**, fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
2. Type HD, Heavy Duty, Single Throw, 240 **OR** 600, **as directed**, -V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified **OR** indicated, **as directed**, fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
3. Type HD, Heavy Duty, Six Pole, Single Throw, 240 **OR** 600, **as directed**, -V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified **OR** indicated, **as directed**, fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
4. Type HD, Heavy Duty, Double Throw, 240 **OR** 600, **as directed**, -V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified **OR** indicated, **as directed**, fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
5. Accessories:
  - a. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - b. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - c. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - d. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  - e. Auxiliary Contact Kit: One **OR** Two, **as directed**, NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
  - f. Hookstick Handle: Allows use of a hookstick to operate the handle.
  - g. Lugs: Mechanical **OR** Compression, **as directed**, type, suitable for number, size, and conductor material.
  - h. Service-Rated Switches: Labeled for use as service equipment.
  - i. Accessory Control Power Voltage: Remote mounted and powered; 24-V ac **OR** 120-V ac **OR** 208-V ac **OR** 240-V ac **OR** 6-V dc **OR** 12-V dc **OR** 24-V dc, **as directed**.

### B. Nonfusible Switches

1. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.



2. Type HD, Heavy Duty, Single Throw, 240 **OR** 600, **as directed**,-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
3. Type HD, Heavy Duty, Six Pole, Single Throw, 240 **OR** 600, **as directed**,-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
4. Type HD, Heavy Duty, Double Throw, 240 **OR** 600, **as directed**,-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
5. Accessories:
  - a. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - b. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - c. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - d. Auxiliary Contact Kit: One **OR** Two, **as directed**, NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
  - e. Hookstick Handle: Allows use of a hookstick to operate the handle.
  - f. Lugs: Mechanical **OR** Compression, **as directed**, type, suitable for number, size, and conductor material.
  - g. Accessory Control Power Voltage: Remote mounted and powered; 24-V ac **OR** 120-V ac **OR** 208-V ac **OR** 240-V ac **OR** 6-V dc **OR** 12-V dc **OR** 24-V dc, **as directed**.

#### C. Receptacle Switches

1. Type HD, Heavy-Duty, Single-Throw Fusible Switch: 240 **OR** 600, **as directed**,-V ac, 30 **OR** 60 **OR** 100, **as directed**, A; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate specified **OR** indicated, **as directed**, fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
2. Type HD, Heavy-Duty, Single-Throw Nonfusible Switch: 240 **OR** 600, **as directed**,-V ac, 30 **OR** 60 **OR** 100, **as directed**, A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
3. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.
4. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

#### D. Shunt Trip Switches

1. General Requirements: Comply with ASME A17.1, **as directed**, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
2. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
3. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer **OR** source, **as directed**, of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.
4. Accessories:
  - a. Oiltight key switch for key-to-test function.
  - b. Oiltight red **OR** green **OR** white **OR** yellow, **as directed**, ON pilot light.
  - c. Isolated neutral lug; 100 **OR** 200, **as directed**, percent rating.
  - d. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
  - e. Form C alarm contacts that change state when switch is tripped.



- f. Three-pole, double-throw, fire-safety and alarm relay; 120-V ac **OR** 24-V dc, **as directed**, coil voltage.
- g. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

E. Molded-Case Circuit Breakers

1. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
2. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
4. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
  - a. Instantaneous trip.
  - b. Long- and short-time pickup levels.
  - c. Long- and short-time time adjustments.
  - d. Ground-fault pickup level, time delay, and  $I^2t$  response.
5. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
6. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
7. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
8. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
9. Features and Accessories:
  - a. Standard frame sizes, trip ratings, and number of poles.
  - b. Lugs: Mechanical **OR** Compression, **as directed**, type, suitable for number, size, trip ratings, and conductor material.
  - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
  - d. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered **OR** remote-mounted and powered, **as directed**, type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
  - e. Communication Capability: Circuit-breaker-mounted **OR** Universal-mounted **OR** Integral **OR** Din-rail-mounted, **as directed**, communication module with functions and features compatible with power monitoring and control system, specified in Division 26 Section "Electrical Power Monitoring And Control".
  - f. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
  - g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
  - h. Auxiliary Contacts: One SPDT switch **OR** Two SPDT switches, **as directed**, with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
  - i. Alarm Switch: One NO **OR** NC, **as directed**, contact that operates only when circuit breaker has tripped.
  - j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
  - k. Zone-Selective Interlocking: Integral with electronic **OR** ground-fault, **as directed**, trip unit; for interlocking ground-fault protection function.
  - l. Electrical Operator: Provide remote control for on, off, and reset operations.



- m. Accessory Control Power Voltage: Integrally mounted, self-powered **OR** Remote mounted and powered, **as directed**; 24-V ac **OR** 120-V ac **OR** 208-V ac **OR** 240-V ac **OR** 6-V dc **OR** 12-V dc **OR** 24-V dc, **as directed**.

#### F. Molded-Case Switches

1. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
2. Features and Accessories:
  - a. Standard frame sizes and number of poles.
  - b. Lugs: Mechanical **OR** Compression, **as directed**, type, suitable for number, size, trip ratings, and conductor material.
  - c. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
  - d. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
  - e. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
  - f. Auxiliary Contacts: One SPDT switch **OR** Two SPDT switches, **as directed**, with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
  - g. Alarm Switch: One NO **OR** NC, **as directed**, contact that operates only when switch has tripped.
  - h. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
  - i. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
  - j. Electrical Operator: Provide remote control for on, off, and reset operations.
  - k. Accessory Control Power Voltage: Integrally mounted, self-powered **OR** Remote mounted and powered, **as directed**; 24-V ac **OR** 120-V ac **OR** 208-V ac **OR** 240-V ac **OR** 6-V dc **OR** 12-V dc **OR** 24-V dc, **as directed**.

#### G. Enclosures

1. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
  - a. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  - b. Outdoor Locations: NEMA 250, Type 3R.
  - c. Kitchen **OR** Wash-Down, **as directed**, Areas: NEMA 250, Type 4X, stainless steel.
  - d. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
  - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
  - f. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7 **OR** Type 9, **as directed**.

### 1.3 EXECUTION

#### A. Installation

1. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
2. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
3. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
4. Install fuses in fusible devices.
5. Comply with NECA 1.



- B. Identification
1. Comply with requirements in Division 26 Section "Identification For Electrical Systems".
    - a. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
    - b. Label each enclosure with engraved metal or laminated-plastic nameplate.
- C. Field Quality Control
1. Perform tests and inspections.
  2. Acceptance Testing Preparation:
    - a. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
    - b. Test continuity of each circuit.
  3. Tests and Inspections:
    - a. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
    - b. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
    - c. Perform the following infrared scan tests and inspections and prepare reports:
      - 1) Initial Infrared Scanning: After Final Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
      - 2) Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Final Completion.
      - 3) Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    - d. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
  4. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
  5. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- D. Adjusting
1. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
  2. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".

END OF SECTION 26 24 13 00a



## SECTION 26 24 13 00b - SWITCHBOARDS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for switchboards. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Service and distribution switchboards rated 600 V and less.
  - b. Transient voltage suppression devices.
  - c. Disconnecting and overcurrent protective devices.
  - d. Instrumentation.
  - e. Control power.
  - f. Accessory components and features.
  - g. Identification.
  - h. Mimic bus.

#### C. Performance Requirements

1. Seismic Performance: Switchboards 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."

#### D. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: For each switchboard and related equipment.
  - a. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
  - b. Detail enclosure types for types other than NEMA 250, Type 1.
  - c. Detail bus configuration, current, and voltage ratings.
  - d. Detail short-circuit current rating of switchboards and overcurrent protective devices.
  - e. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
  - f. Detail utility company's metering provisions with indication of approval by utility company.
  - g. Include evidence of NRTL listing for series rating of installed devices.
  - h. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - i. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
  - j. Include diagram and details of proposed mimic bus.
  - k. Include schematic and wiring diagrams for power, signal, and control wiring.
3. Samples: Representative portion of mimic bus with specified material and finish, for color selection.
4. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
5. Field Quality-Control Reports.



6. Operation and maintenance data.

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 NEMA PB 2.
3. Comply with NFPA 70.
4. Comply with UL 891.

F. Delivery, Storage, And Handling

1. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
2. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) **OR** connect factory-installed space heaters to temporary electrical service, **as directed**, to prevent condensation.
3. Handle and prepare switchboards for installation according to NECA 400 **OR** NEMA PB 2.1, **as directed**.

G. Project Conditions

1. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - a. Notify the Owner no fewer than seven days in advance of proposed interruption of electric service.
  - b. Indicate method of providing temporary electric service.
  - c. Do not proceed with interruption of electric service without the Owner's written permission.
  - d. Comply with NFPA 70E.

H. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within five years from date of Final Completion.

## 1.2 PRODUCTS

A. Manufactured Units

1. Front-Connected, Front-Accessible Switchboards:
  - a. Main Devices: Panel **OR** Fixed, individually, **as directed**, mounted.
  - b. Branch Devices: Panel mounted.
  - c. Sections front and rear aligned.
2. Front- and Side-Accessible Switchboards:
  - a. Main Devices: Fixed, individually mounted.
  - b. Branch Devices: Panel mounted.
  - c. Sections front and rear aligned.
3. Front- and Rear-Accessible Switchboards:
  - a. Main Devices: Fixed, individually **OR** Drawout, **as directed**, mounted.
  - b. Branch Devices: Panel **OR** Fixed, individually **OR** Panel and fixed, individually **OR** Fixed and individually compartmented **OR** Individually compartmented and drawout, **as directed**, mounted.
  - c. Sections front and rear **OR** rear, **as directed**, aligned.
4. Nominal System Voltage: 480Y/277 V **OR** 208Y/120 V, **as directed**.
5. Main-Bus Continuous: 5000 **OR** 4000 **OR** 3000 **OR** 2500 **OR** 2000 **OR** 1600 **OR** 1200, **as directed**, A.



6. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
7. Indoor Enclosures: Steel, NEMA 250, Type 1 **OR** Type 5, **as directed**.
8. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray **OR** custom color, **as directed**, finish over a rust-inhibiting primer on treated metal surface.
9. Outdoor Enclosures: Type 3R **OR** Type 3R, with interior-lighted walk-in aisle, **as directed**.
  - a. Finish: Factory-applied finish in manufacturer's standard **OR** custom, **as directed**, color; undersurfaces treated with corrosion-resistant undercoating.
  - b. Enclosure: Flat **OR** Downward, rearward sloping, **as directed**, roof; bolt-on rear covers **OR** rear hinged doors, **as directed**, for each section, with provisions for padlocking.
  - c. Doors: Personnel door at each end of aisle, minimum width of 30 inches (762 mm); opening outwards; with panic hardware and provisions for padlocking **OR** cylinder lock, **as directed**.
  - d. Accessories: Fluorescent lighting fixtures, ceiling mounted; wired to a three-way light switch at each end of aisle; ground-fault circuit interrupter (GFCI) duplex receptacle; emergency battery pack lighting fixture installed on wall of aisle midway between personnel doors.
  - e. Walk-in Aisle Heating and Ventilating:
    - 1) Factory-installed electric unit heater(s), wall or ceiling mounted, with integral thermostat and disconnect and with capacities to maintain switchboard interior temperature of 40 deg F (5 deg C) with outside design temperature of 104 deg F (40 deg C).
    - 2) Factory-installed exhaust fan with capacities to maintain switchboard interior temperature of 100 deg F (38 deg C) with outside design temperature of 23 deg F (minus 5 deg C).
    - 3) Ventilating openings complete with replaceable fiberglass air filters.
    - 4) Thermostat: Single stage; wired to control heat and exhaust fan.
  - f. Power for Space Heaters, Ventilation, Lighting, and Receptacle: Include a control-power transformer within the switchboard. Supply voltage shall be 120 **OR** 120/240 **OR** 120/208, **as directed**, -V ac.
  - g. Power for space heaters, ventilation, lighting, and receptacle provided by a remote source.
10. Barriers: Between adjacent switchboard sections.
11. Insulation and isolation for main bus of main section, **as directed**, and main and vertical buses of feeder sections.
12. Cubical Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
  - a. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point **OR** Manual switching of branch-circuit protective device, **as directed**.
  - b. Space-Heater Power Source: Transformer, factory installed in switchboard **OR** 120-V external branch circuit, **as directed**.
13. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
14. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks, **as directed**.
15. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
16. Removable, Hinged Rear Doors and Compartment Covers: Secured by captive thumb screws **OR** standard bolts, **as directed**, for access to rear interior of switchboard.
17. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.



18. Pull Box on Top of Switchboard:
  - a. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
  - b. Set back from front to clear circuit-breaker removal mechanism.
  - c. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
  - d. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
  - e. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
19. Buses and Connections: Three phase, four wire unless otherwise indicated.
  - a. Phase- and Neutral-Bus Material: One of the following:
    - 1) Hard-drawn copper of 98 percent conductivity, silver-plated, **as directed**, with tin-plated aluminum or copper feeder circuit-breaker line connections.
    - 2) Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.
    - 3) Hard-drawn copper of 98 percent conductivity, silver-plated, **as directed**, or tin-plated, high-strength, electrical-grade aluminum alloy.
  - b. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical **OR** compression, **as directed**, connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
  - c. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) **OR** 1/4-by-1-inch- (6-by-25-mm-) **OR** Minimum-size required by UL 891, **as directed**, hard-drawn copper of 98 percent conductivity, equipped with mechanical **OR** compression, **as directed**, connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
  - d. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
  - e. Neutral Buses: 50 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical **OR** compression, **as directed**, connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
  - f. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical **OR** compression, **as directed**, connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
  - g. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
20. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
21. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.
22. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

#### B. Transient Voltage Suppression Devices

1. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, wired-in **OR** plug-in **OR** bolt-on, **as directed**, solid-state, parallel-connected, modular (with field-replaceable modules) **OR** non-modular, **as directed**, type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:
  - a. Fuses, rated at 200-kA interrupting capacity.
  - b. Fabrication using bolted compression lugs for internal wiring.
  - c. Integral disconnect switch.
  - d. Redundant suppression circuits.
  - e. Redundant replaceable modules.
  - f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.



- g. LED indicator lights for power and protection status.
  - h. Audible alarm, with silencing switch, to indicate when protection has failed.
  - i. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
  - j. Four **OR** Six, **as directed**, -digit, transient-event counter set to totalize transient surges.
- 2. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase **OR** 120 kA per mode/240 kA per phase **OR** 80 kA per mode/160 kA per phase, **as directed**.
  - 3. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
  - 4. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 **OR** 208Y/120 **OR** 600Y/347, **as directed**, -V, three-phase, four-wire circuits shall be as follows:
    - a. Line to Neutral: 800 V for 480Y/277 **OR** 400 V for 208Y/120 **OR** 1200 V for 600Y/347, **as directed**.
    - b. Line to Ground: 800 V for 480Y/277 **OR** 400 V for 208Y/120 **OR** 1200 V for 600Y/347, **as directed**.
    - c. Neutral to Ground: 800 V for 480Y/277 **OR** 400 V for 208Y/120 **OR** 1200 V for 600Y/347, **as directed**.
  - 5. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:
    - a. Line to Neutral: 400 V, 800 V from high leg.
    - b. Line to Ground: 400 V.
    - c. Neutral to Ground: 400 V.
  - 6. Protection modes and UL 1449 SVR for 240-, 480-, or 600-V, three-phase, three-wire, delta circuits shall be as follows:
    - a. Line to Line: 2000 V for 480 V **OR** 1000 V for 240 V **OR** 2500 V for 600 V, **as directed**.
    - b. Line to Ground: 1500 V for 480 V **OR** 800 V for 240 V **OR** 2500 V for 600 V, **as directed**.
- C. Disconnecting And Overcurrent Protective Devices
- 1. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating **OR** interrupting capacity, **as directed**, to meet available fault currents.
    - a. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    - b. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
    - c. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
      - 1) Instantaneous trip.
      - 2) Long- and short-time pickup levels.
      - 3) Long- and short-time time adjustments.
      - 4) Ground-fault pickup level, time delay, and  $I^2t$  response.
    - d. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
    - e. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
    - f. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
    - g. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
    - h. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
      - 1) Standard frame sizes, trip ratings, and number of poles.
      - 2) Lugs: Mechanical **OR** Compression, **as directed**, style, suitable for number, size, trip ratings, and conductor material.



- 3) Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
  - 4) Ground-Fault Protection: Integrally mounted **OR** Remote-mounted, **as directed**, relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  - 5) Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
  - 6) Communication Capability: Circuit-breaker-mounted **OR** Universal-mounted **OR** Integral **OR** Din-rail-mounted, **as directed**, communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring And Control".
  - 7) Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 **OR** 75, **as directed**, percent of rated voltage.
  - 8) Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
  - 9) Auxiliary Contacts: One SPDT switch **OR** Two SPDT switches, **as directed**, with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
  - 20) Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
2. Insulated-Case Circuit Breaker (ICCB): 80 **OR** 100, **as directed**, percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
- a. Fixed **OR** Drawout, **as directed**, circuit-breaker mounting.
  - b. Two-step, stored-energy closing.
  - c. Standard **OR** Full, **as directed**,-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
    - 1) Instantaneous trip.
    - 2) Long- and short-time time adjustments.
    - 3) Ground-fault pickup level, time delay, and  $I^2t$  response.
  - d. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
  - e. Remote trip indication and control.
  - f. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring And Control".
  - g. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
  - h. Control Voltage: 40-V dc **OR** 125-V dc **OR** 250-V dc **OR** 120-V ac, **as directed**.
3. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.
- a. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.
  - b. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.
    - 1) Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
    - 2) Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.
  - c. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
  - d. Service-Rated Switches: Labeled for use as service equipment.



- e. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.
  - 1) Configuration: Integrally mounted **OR** Remote-mounted, **as directed**, relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  - 2) Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
  - 3) No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
  - 4) Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).
- f. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.
- 4. High-Pressure, Butt-Type Contact Switch: Operating mechanism uses butt-type contacts and a spring-charged mechanism to produce and maintain high-pressure contact when switch is closed.
  - a. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.
  - b. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.
    - 1) Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
    - 2) Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.
  - c. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
  - d. Service-Rated Switches: Labeled for use as service equipment.
  - e. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.
    - 1) Configuration: Integrally mounted **OR** Remote-mounted, **as directed**, relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    - 2) Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
    - 3) No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
    - 4) Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).
  - f. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.
- 5. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- 6. Fuses are specified in Division 26 Section "Fuses".

#### D. Instrumentation

- 1. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
  - a. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, single **OR** tapped **OR** double, **as directed**, secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
  - b. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound **OR** bushing **OR** bar or window, **as directed**, type; single **OR** double, **as directed**, secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
  - c. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
  - d. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.



2. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
  - a. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    - 1) Phase Currents, Each Phase: Plus or minus 1 percent.
    - 2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
    - 3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
    - 4) Megawatts: Plus or minus 2 percent.
    - 5) Megavars: Plus or minus 2 percent.
    - 6) Power Factor: Plus or minus 2 percent.
    - 7) Frequency: Plus or minus 0.5 percent.
    - 8) Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
    - 9) Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
    - 10) Contact devices to operate remote impulse-totalizing demand meter.
  - b. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
3. Ammeters, Voltmeters, and Power-Factor Meters: ANSI C39.1.
  - a. Meters: 4-inch (100-mm) diameter or 6 inches (150 mm) square, flush or semiflush, with antiparallax 250-degree scales and external zero adjustment.
  - b. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.
4. Instrument Switches: Rotary type with off position.
  - a. Voltmeter Switches: Permit reading of all phase-to-phase voltages and, where a neutral is indicated, phase-to-neutral voltages.
  - b. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.
5. Feeder Ammeters: 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for indicated feeder circuits only.
6. Watt-Hour Meters and Wattmeters:
  - a. Comply with ANSI C12.1.
  - b. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
  - c. Suitable for connection to three- and four-wire circuits.
  - d. Potential indicating lamps.
  - e. Adjustments for light and full load, phase balance, and power factor.
  - f. Four-dial clock register.
  - g. Integral demand indicator.
  - h. Contact devices to operate remote impulse-totalizing demand meter.
  - i. Ratchets to prevent reverse rotation.
  - j. Removable meter with drawout test plug.
  - k. Semiflush mounted case with matching cover.
  - l. Appropriate multiplier tag.
7. Impulse-Totalizing Demand Meter:
  - a. Comply with ANSI C12.1.
  - b. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
  - c. Cyclometer.
  - d. Four-dial, totalizing kilowatt-hour register.
  - e. Positive chart drive mechanism.
  - f. Capillary pen holding a minimum of one month's ink supply.
  - g. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
  - h. Capable of indicating and recording five **OR** 15 **OR** 30, **as directed**,-minute integrated demand of totalized system.



- E. Control Power
1. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer **OR** 120-V ac, supplied from remote branch circuit, **as directed**.
  2. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.
  3. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
  4. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
- F. Accessory Components And Features
1. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
  2. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.
  3. Portable Circuit-Breaker Lifting Device: Floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.
  4. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.
  5. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.
- G. Identification
1. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on a photoengraved nameplate.
    - a. Nameplate: At least 0.032-inch- (0.813-mm-) thick anodized aluminum, located at eye level on front cover of the switchboard incoming service section.
  2. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on an engraved laminated-plastic (Gravoply) nameplate.
    - a. Nameplate: At least 0.0625-inch- (1.588 mm-) thick laminated plastic (Gravoply), located at eye level on front cover of the switchboard incoming service section.
  3. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.
  4. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.
  5. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.
  6. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

### 1.3 EXECUTION

- A. Installation
1. Install switchboards and accessories according to NECA 400 **OR** NEMA PB 2.1, **as directed**.
  2. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
    - a. 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.



- b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - d. Install anchor bolts to elevations required for proper attachment to switchboards.
3. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
  4. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers And Supports For Electrical Systems".
  5. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
  6. Install filler plates in unused spaces of panel-mounted sections.
  7. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
    - a. Set field-adjustable switches and circuit-breaker trip ranges.
  8. Install spare-fuse cabinet.
  9. Comply with NECA 1.
- B. Connections
1. Comply with requirements for terminating feeder bus specified in Division 26 Section "Enclosed Bus Assemblies". Drawings indicate general arrangement of bus, fittings, and specialties.
  2. Comply with requirements for terminating cable trays specified in Division 26 Section "Cable Trays For Electrical Systems". Drawings indicate general arrangement of cable trays, fittings, and specialties.
- C. Identification
1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".
  2. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".
  3. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".
- D. Field Quality Control
1. Acceptance Testing Preparation:
    - a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
    - b. Test continuity of each circuit.
  2. Tests and Inspections:
    - a. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
    - b. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
    - c. Perform the following infrared scan tests and inspections and prepare reports:
      - 1) Initial Infrared Scanning: After Final Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front **OR** front and rear, **as directed**, panels so joints and connections are accessible to portable scanner.
      - 2) Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Final Completion.
      - 3) Instruments and Equipment:



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- a) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - d. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
  3. Switchboard will be considered defective if it does not pass tests and inspections.
  4. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- E. Adjusting
1. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
  2. Set field-adjustable circuit-breaker trip ranges as indicated **OR** as specified in Division 26 Section "Overcurrent Protective Device Coordination Study", **as directed**.
- F. Protection
1. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

END OF SECTION 26 24 13 00b



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 24 16 00	01 51 13 00	Panelboards

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## SECTION 26 24 19 00 - ENCLOSED CONTROLLERS

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. Section includes the following enclosed controllers rated 600 V and less:
  - a. Full-voltage manual.
  - b. Full-voltage magnetic.
  - c. Reduced-voltage magnetic.
  - d. Reduced-voltage solid state.
  - e. Multispeed.

#### C. Definitions

1. CPT: Control power transformer.
2. MCCB: Molded-case circuit breaker.
3. MCP: Motor circuit protector.
4. N.C.: Normally closed.
5. N.O.: Normally open.
6. OCPD: Overcurrent protective device.
7. SCR: Silicon-controlled rectifier.

#### D. Performance Requirements

1. Seismic Performance: Enclosed controllers 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 enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.
2. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
  - a. Show tabulations of the following:
    - 1) Each installed unit's type and details.
    - 2) Factory-installed devices.
    - 3) Nameplate legends.
    - 4) Short-circuit current rating of integrated unit.
    - 5) Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
    - 6) Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
  - b. Wiring Diagrams: For power, signal, and control wiring.
3. Qualification Data: For qualified testing agency.
4. Seismic Qualification Certificates: For enclosed controllers, 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: For enclosed controllers to include in emergency, operation, and maintenance manuals. Include the following:
    - a. Routine maintenance requirements for enclosed controllers and installed components.
    - b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
    - c. Manufacturer's written instructions for setting field-adjustable overload relays.
    - d. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.
  7. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
  8. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.
- F. Quality Assurance
1. 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.
  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. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
- G. Delivery, Storage, And Handling
1. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
  2. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 250 W per controller **OR** connect factory-installed space heaters to temporary electrical service, **as directed**.
- H. Project Conditions
1. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
    - b. Altitude: Not exceeding 6600 feet (2010 m).
  2. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in 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 systems.
    - b. Indicate method of providing temporary utilities.
    - c. Do not proceed with interruption of electrical systems without the Owner's written permission.
    - d. Comply with NFPA 70E.



- I. Coordination
  1. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
  2. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
  3. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

## 1.2 PRODUCTS

- A. Full-Voltage Controllers
  1. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
  2. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
    - a. Configuration: Nonreversing **OR** Reversing **OR** Two speed, **as directed**.
    - b. Flush **OR** Surface, **as directed**, mounting.
    - c. Red **OR** Green, **as directed**, pilot light.
    - d. Additional Nameplates: FORWARD and REVERSE for reversing switches **OR** HIGH and LOW for two-speed switches, **as directed**.
  3. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
    - a. Configuration: Nonreversing **OR** Two speed, **as directed**.
    - b. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type **OR** melting alloy type, **as directed**.
    - c. Flush **OR** Surface, **as directed**, mounting.
    - d. Red **OR** Green, **as directed**, pilot light.
    - e. Additional Nameplates: HIGH and LOW for two-speed controllers.
  4. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
    - a. Configuration: Nonreversing **OR** Reversing **OR** Two speed, **as directed**.
    - b. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type **OR** melting alloy type, **as directed**.
    - c. Flush **OR** Surface, **as directed**, mounting.
    - d. Red **OR** Green, **as directed**, pilot light.
    - e. Additional Nameplates: FORWARD and REVERSE for reversing controllers **OR** HIGH and LOW for two-speed controllers, **as directed**.
    - f. N.O. **OR** N.C., **as directed**, auxiliary contact.
  5. Magnetic Controllers: Full voltage, across the line, electrically held.
    - a. Configuration: Nonreversing **OR** Reversing, **as directed**.
    - b. Contactor Coils: Pressure-encapsulated type with coil transient suppressors, **as directed**.
      - 1) Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
    - c. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
    - d. Control Circuits: 24 **OR** 120, **as directed**, -V ac; obtained from integral CPT, with primary and secondary fuses, **as directed**, with CPT **OR** control power source, **as directed**, of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
      - 1) CPT Spare Capacity: 50 **OR** 100 **OR** 200, **as directed**, VA.
    - e. Melting Alloy Overload Relays:



- 1) Inverse-time-current characteristic.
- 2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
- 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
- f. Bimetallic Overload Relays:
  - 1) Inverse-time-current characteristic.
  - 2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
  - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
  - 4) Ambient compensated.
  - 5) Automatic resetting.
- g. Solid-State Overload Relay:
  - 1) Switch or dial selectable for motor running overload protection.
  - 2) Sensors in each phase.
  - 3) Class 10 **OR** Class 20 **OR** Class 10/20 selectable, **as directed**, tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
  - 4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
  - 5) Analog communication module.
- h. N.C. **OR** N.O., **as directed**, isolated overload alarm contact.
- i. External overload reset push button.
6. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
  - a. Fusible Disconnecting Means:
    - 1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class J **OR** Class R **OR** indicated, **as directed**, fuses.
    - 2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - 3) Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
  - b. Nonfusible Disconnecting Means:
    - 1) NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
    - 2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - 3) Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
  - c. MCP Disconnecting Means:
    - 1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
    - 2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - 3) Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
    - 4) N.C. **OR** N.O., **as directed**, alarm contact that operates only when MCP has tripped.
    - 5) Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
  - d. MCCB Disconnecting Means:
    - 1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
    - 2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    - 3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - 4) Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.



- 5) N.C. **OR** N.O., **as directed**, alarm contact that operates only when MCCB has tripped.
- B. Reduced-Voltage Magnetic Controllers
1. General Requirements for Reduced-Voltage Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A; closed-transition; adjustable time delay on transition.
  2. Reduced-Voltage Magnetic Controllers: Reduced voltage, electrically held.
    - a. Configuration:
      - 1) Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.
      - 2) Part-Winding Controller: Separate START and RUN contactors, field-selectable for 1/2- or 2/3-winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
      - 3) Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.
    - b. Contactor Coils: Pressure-encapsulated type with coil transient suppressors, **as directed**.
      - 1) Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
    - c. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
    - d. Control Circuits: 24 **OR** 120, **as directed**, -V ac; obtained from integral CPT, with primary and secondary fuses, **as directed**, with CPT **OR** control power source, **as directed**, of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
      - 1) CPT Spare Capacity: 50 **OR** 100 **OR** 200, **as directed**, VA.
    - e. Melting Alloy Overload Relays:
      - 1) Inverse-time-current characteristic.
      - 2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
      - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
    - f. Bimetallic Overload Relays:
      - 1) Inverse-time-current characteristic.
      - 2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
      - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
      - 4) Ambient compensated.
      - 5) Automatic resetting.
    - g. Solid-State Overload Relay:
      - 1) Switch or dial selectable for motor running overload protection.
      - 2) Sensors in each phase.
      - 3) Class 10 **OR** Class 20 **OR** Class 10/20 selectable, **as directed**, tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
      - 4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
      - 5) Analog communication module.
    - h. N.C. **OR** N.O., **as directed**, isolated overload alarm contact.
    - i. External overload reset push button.
  3. Combination Reduced-Voltage Magnetic Controller: Factory-assembled combination of reduced-voltage magnetic controller, OCPD, and disconnecting means.
    - a. Fusible Disconnecting Means:
      - 1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class J **OR** Class R **OR** indicated, **as directed**, fuses.
      - 2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.



- 3) Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
  - b. Nonfusible Disconnecting Means:
    - 1) NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
    - 2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - 3) Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
  - c. MCP Disconnecting Means:
    - 1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
    - 2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - 3) Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
    - 4) N.C. **OR** N.O., **as directed**, alarm contact that operates only when MCP has tripped.
    - 5) Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
  - d. MCCB Disconnecting Means:
    - 1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
    - 2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    - 3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - 4) Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
    - 5) N.C. **OR** N.O., **as directed**, alarm contact that operates only when MCCB has tripped.
- C. Reduced-Voltage Solid-State Controllers
1. General Requirements for Reduced-Voltage Solid-State Controllers: Comply with UL 508.
  2. Reduced-Voltage Solid-State Controllers: An integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relay; suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
    - a. Configuration: Standard duty **OR** Severe duty, **as directed**; nonreversible **OR** reversible, **as directed**.
    - b. Starting Mode: Voltage ramping **OR** Current limit **OR** Torque control **OR** Torque control with voltage boost, **as directed**; field selectable, **as directed**.
    - c. Stopping Mode: Coast to stop **OR** Adjustable torque deceleration **OR** Adjustable braking, **as directed**; field selectable, **as directed**.
    - d. Shorting (Bypass) Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Solid-state controller protective features shall remain active when the shorting contactor is in the bypass mode.
    - e. Shorting and Input Isolation, **as directed**, Contactor Coils: Pressure-encapsulated type; manufacturer's standard operating voltage, matching control power or line voltage, depending on contactor size and line-voltage rating. Provide coil transient suppressors, **as directed**.
    - f. Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
    - g. Control Circuits: 24 **OR** 120, **as directed**, -V ac; obtained from integral CPT, with primary and secondary fuses, **as directed**, with CPT **OR** control power source, **as directed**, of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
      - 1) CPT Spare Capacity: 100 **OR** 200, **as directed**, VA.



- h. Adjustable acceleration-rate control using voltage or current ramp, and adjustable starting torque control with up to 400 percent current limitation for 20 seconds.
- i. SCR bridge shall consist of at least two SCRs per phase, providing stable and smooth acceleration with **OR** without, **as directed**, external feedback from the motor or driven equipment.
- j. Keypad, front accessible; for programming the controller parameters, functions, and features; shall be manufacturer's standard and include not less than the following functions:
  - 1) Adjusting motor full-load amperes, as a percentage of the controller's rating.
  - 2) Adjusting current limitation on starting, as a percentage of the motor full-load current rating.
  - 3) Adjusting linear acceleration and deceleration ramps, in seconds.
  - 4) Initial torque, as a percentage of the nominal motor torque.
  - 5) Adjusting torque limit, as a percentage of the nominal motor torque.
  - 6) Adjusting maximum start time, in seconds.
  - 7) Adjusting voltage boost, as a percentage of the nominal supply voltage.
  - 8) Selecting stopping mode, and adjusting parameters.
  - 9) Selecting motor thermal overload protection class between 5 and 30.
  - 10) Activating and de-activating protection modes.
  - 11) Selecting or activating communication modes.
- k. Digital display, front accessible; for showing motor, controller, and fault status; shall be manufacturer's standard and include not less than the following:
  - 1) Controller Condition: Ready, starting, running, stopping.
  - 2) Motor Condition: Amperes, voltage, power factor, power, and thermal state.
  - 3) Fault Conditions: Controller thermal fault, motor overload alarm and trip, motor underload, overcurrent, shorted SCRs, line or phase loss, phase reversal, and line frequency over or under normal.
- l. Controller Diagnostics and Protection:
  - 1) Microprocessor-based thermal protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
  - 2) Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and underload conditions; and line frequency over or under normal.
  - 3) Input isolation contactor that opens when the controller diagnostics detect a faulted solid-state component or when the motor is stopped.  
**OR**  
Shunt trip that opens the disconnecting means when the controller diagnostics detect a faulted solid-state component.
- m. Remote Output Features:
  - 1) All outputs prewired to terminal blocks.
  - 2) Form C status contacts that change state when controller is running.
  - 3) Form C alarm contacts that change state when a fault condition occurs.
- n. Optional Features:
  - 1) Analog output for field-selectable assignment of motor operating characteristics; 0 to 10-V dc **OR** 4 to 20-mA dc, **as directed**.
  - 2) Additional field-assignable Form C contacts, as indicated, for alarm outputs.
  - 3) Surge suppressors in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
  - 4) Full-voltage bypass contactor operating automatically **OR** manually, with NORMAL/BYPASS selector switch, **as directed**. Power contacts shall be totally enclosed, double break, and silver-cadmium oxide; and assembled to allow inspection and replacement without disturbing line or load wiring.
  - 5) Melting Alloy Overload Relays:
    - a) Inverse-time-current characteristic.
    - b) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.



- c) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
- 6) Bimetallic Overload Relays:
  - a) Inverse-time-current characteristic.
  - b) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
  - c) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
  - d) Ambient compensated.
  - e) Automatic resetting.
- 7) Solid-State Overload Relay:
  - a) Switch or dial selectable for motor running overload protection.
  - b) Sensors in each phase.
  - c) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
  - d) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
  - e) Analog communication module.
- 8) N.C. **OR** N.O., **as directed**, isolated overload alarm contact.
- 9) External overload reset push button.
- 3. Combination Reduced-Voltage Solid-State Controller: Factory-assembled combination of reduced-voltage solid-state controller, OCPD, and disconnecting means.
  - a. Fusible Disconnecting Means:
    - 1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class J **OR** Class L **OR** indicated, **as directed**, fuses.
    - 2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - 3) Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
  - b. MCP Disconnecting Means:
    - 1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
    - 2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - 3) Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
    - 4) N.C. **OR** N.O., **as directed**, alarm contact that operates only when MCP has tripped.
    - 5) Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
  - c. MCCB Disconnecting Means:
    - 1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
    - 2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    - 3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - 4) Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
    - 5) N.C. **OR** N.O., **as directed**, alarm contact that operates only when MCCB has tripped.
  - d. Molded-Case Switch Disconnecting Means:
    - 1) UL 489, NEMA AB 1, and NEMA AB 3, with in-line fuse block for Class J or L power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
    - 2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.



- 3) Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
- 4) N.C. **OR** N.O., **as directed**, alarm contact that operates only when molded-case switch has tripped.

D. Multispeed Magnetic Controllers

1. General Requirements for Multispeed Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A.
2. Multispeed Magnetic Controllers: Two speed, full voltage, across the line, electrically held.
  - a. Configuration: Nonreversing **OR** Reversing, **as directed**; consequent pole **OR** two winding, **as directed**.
  - b. Contactor Coils: Pressure-encapsulated type with coil transient suppressors, **as directed**.
    - 1) Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
  - c. Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
  - d. Control Circuits: 24 **OR** 120, **as directed**, -V ac; obtained from integral CPT, with primary and secondary fuses, **as directed**, with CPT **OR** control power source, **as directed**, of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
    - 1) CPT Spare Capacity: 50 **OR** 100 **OR** 200, **as directed**, VA.
  - e. Compelling relays shall ensure that motor will start only at low speed.
  - f. Accelerating timer relays shall ensure properly timed acceleration through speeds lower than that selected.
  - g. Decelerating timer relays shall ensure automatically timed deceleration through each speed.
  - h. Antiplugging timer relays shall ensure a time delay when transferring from FORWARD to REVERSE and back.
  - i. Melting Alloy Overload Relays:
    - 1) Inverse-time-current characteristic.
    - 2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
    - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
  - j. Bimetallic Overload Relays:
    - 1) Inverse-time-current characteristic.
    - 2) Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic.
    - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
    - 4) Ambient compensated.
    - 5) Automatic resetting.
  - k. Solid-State Overload Relay:
    - 1) Switch or dial selectable for motor running overload protection.
    - 2) Sensors in each phase.
    - 3) Class 10 **OR** Class 20 **OR** Class 10/20 selectable, **as directed**, tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
    - 4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
    - 5) Analog communication module.
  - l. N.C. **OR** N.O., **as directed**, isolated overload alarm contact.
  - m. External overload reset push button.
3. Combination Multispeed Magnetic Controller: Factory-assembled combination of reduced-voltage magnetic controller, OCPD, and disconnecting means.
  - a. Fusible Disconnecting Means:
    - 1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class J **OR** Class R **OR** indicated, **as directed**, fuses.



- 2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- 3) Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
- b. Nonfusible Disconnecting Means:
  - 1) NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
  - 2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
  - 3) Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
- c. MCP Disconnecting Means:
  - 1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
  - 2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
  - 3) Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
  - 4) N.C. **OR** N.O., **as directed**, alarm contact that operates only when MCP has tripped.
  - 5) Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
- d. MCCB Disconnecting Means:
  - 1) UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
  - 2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - 3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
  - 4) Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
  - 5) N.C. **OR** N.O., **as directed**, alarm contact that operates only when MCCB has tripped.

#### E. Enclosures

1. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
  - a. Dry and Clean Indoor Locations: Type 1.
  - b. Outdoor Locations: Type 3R **OR** Type 4X, **as directed**.
  - c. Kitchen **OR** Wash-Down, **as directed**, Areas: Type 4X, stainless steel.
  - d. Other Wet or Damp Indoor Locations: Type 4.
  - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
  - f. Hazardous Areas Indicated on Drawings: Type 7 **OR** Type 9, **as directed**.

#### F. Accessories

1. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
  - a. Push Buttons, Pilot Lights, and Selector Switches: Heavy **OR** Standard, **as directed**, -duty, oiltight, **as directed**, type.
    - 1) Push Buttons: Covered **OR** Lockable **OR** Recessed **OR** Shielded **OR** Shrouded **OR** Unguarded, **as directed**, types; maintained **OR** momentary, **as directed**, as indicated.
    - 2) Pilot Lights: Incandescent **OR** LED **OR** Neon **OR** Resistor **OR** Transformer, **as directed**, types; colors as indicated; push to test, **as directed**.
    - 3) Selector Switches: Rotary type.
  - b. Elapsed Time Meters: Heavy duty with digital readout in hours; nonresettable **OR** resettable, **as directed**.



- c. Meters: Panel type, 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.
2. N.C. **OR** N.O. **OR** Reversible N.C./N.O., **as directed**, auxiliary contact(s).
3. Control Relays: Auxiliary and adjustable pneumatic **OR** solid-state, **as directed**, time-delay relays.
4. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
5. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4 **OR** Type 4X **OR** Type 7 **OR** Type 9, **as directed**, enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
6. Space heaters, with N.C. auxiliary contacts, to mitigate condensation in Type 3R **OR** Type 4X **OR** Type 12, **as directed**, enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
7. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
8. Cover gaskets for Type 1 enclosures.
9. Terminals for connecting power factor correction capacitors to the line **OR** load, **as directed**, side of overload relays.
10. Spare control wiring terminal blocks, quantity as indicated; unwired **OR** wired, **as directed**.

### 1.3 EXECUTION

#### A. Examination

1. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
2. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

#### B. Installation

1. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers And Supports For Electrical Systems".
2. Floor-Mounted Controllers: Install enclosed controllers on 4-inch (100-mm) nominal-thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
  - a. 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.
  - b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - d. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
4. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
5. Install fuses in each fusible-switch enclosed controller.
6. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses".
7. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.



8. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
  9. Install power factor correction capacitors. Connect to the line **OR** load, **as directed**, side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.
  10. Comply with NECA 1.
- C. Identification
1. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".
    - a. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
    - b. Label each enclosure with engraved nameplate.
    - c. Label each enclosure-mounted control and pilot device.
- D. Control Wiring Installation
1. Install wiring between enclosed controllers and remote devices and facility's central control system, **as directed**. Comply with requirements in Division 26 Section "Control-voltage Electrical Power Cables".
  2. Bundle, train, and support wiring in enclosures.
  3. Connect selector switches and other automatic-control selection devices where applicable.
    - a. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
    - b. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.
- E. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
  2. Perform tests and inspections.
  3. Acceptance Testing Preparation:
    - a. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
    - b. Test continuity of each circuit.
  4. Tests and Inspections:
    - a. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment, **as directed**.
    - b. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
    - c. Test continuity of each circuit.
    - d. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify the Owner before starting the motor(s).
    - e. Test each motor for proper phase rotation.
    - f. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
    - g. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
    - h. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
      - 1) Initial Infrared Scanning: After Final Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multi-pole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
      - 2) Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multi-pole enclosed controller 11 months after date of Final Completion.



- 3) Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    - i. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
  5. Enclosed controllers will be considered defective if they do not pass tests and inspections.
  6. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- F. Adjusting
1. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
  2. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
  3. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify the Owner before increasing settings.
  4. Set the taps on reduced-voltage autotransformer controllers at 50 **OR** 65 **OR** 80, **as directed**, percent.
  5. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.
  6. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study", **as directed**.
- G. Protection
1. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
  2. Replace controllers whose interiors have been exposed to water or other liquids prior to Final Completion.
- H. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage solid-state controllers, **as directed**.

END OF SECTION 26 24 19 00



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## SECTION 26 24 19 00a - POWER DISTRIBUTION UNITS

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. This Section includes freestanding, prepackaged, power distribution units for transforming, conditioning, and distributing electrical power.

#### C. Definitions

1. TVSS: Transient voltage surge suppression.
2. UPS: Uninterrupted power supply.

#### D. Submittals

1. Product Data: For power distribution units.
2. Shop Drawings: Include dimensioned plans, sections, and elevations. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - a. Wiring Diagrams: Power, signal, and control wiring.
3. Manufacturer Seismic Qualification Certification: Submit certification that power distribution units, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems". Include the following:
4. Field quality-control test reports.
5. Operation and Maintenance Data: For power distribution units to include in emergency, operation, and maintenance manuals.

#### E. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Comply with NFPA 70.

#### F. Delivery, Storage, And Handling

1. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.
2. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

### 1.2 PRODUCTS

#### A. Manufactured Units

1. Description: Integrated and coordinated assembly of power-line-conditioning and distribution components packaged in a single cabinet or modular assembly of cabinets each with full-swivel casters mounted to bottom frame, **as directed**. Include the following components:
  - a. Input-power, circuit-breaker section.
  - b. Isolation transformer.
  - c. TVSS system.
  - d. Output panelboard(s).



- e. Alarm, monitoring, and control system.
  2. Provide units that are constructed to withstand seismic forces specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
  3. Unit Capacity Rating: Unit shall carry indicated rms kilovolt-ampere load continuously without exceeding rated insulation temperature for the following input voltage and load current:
    - a. Input Voltage: Within rated input-voltage tolerance band of unit.
    - b. Load Current: Minimum of 3.0 crest factor and 85 percent total harmonic distortion.
- B. Input-Power, Circuit-Breaker Section
1. Description: 3-pole, shunt-tripped, thermal-magnetic-type circuit breaker, rated for indicated interrupting capacity and 125 percent of input current of unit at 100 percent rated load.
    - a. Dual-Input Units:
      - 1) Two input circuit breakers arranged to provide transfer between two input-voltage sources.
      - 2) Controls and interfaces to allow both open- and closed-transition transfer between two input-voltage sources.
      - 3) Use a 120-V permissive signal from both upstream voltage sources to indicate acceptable conditions for closed-transition transfer.
      - 4) Open second circuit breaker automatically after closed-transition transfer is completed.
- C. Isolation Transformer Section
1. Description: Dry-type, electrostatically shielded, three-phase, common-core, convection-air-cooled isolation transformer.
    - a. Comply with UL 1561 including requirements for nonsinusoidal load-current-handling capability defined by designated K-factor, **as directed**.
    - b. Cores: Grain-oriented, non-aging silicon steel, one leg per phase.
    - c. Coil Material and Insulation: Copper windings with a 220 deg C insulation class.
    - d. Temperature Rise: Designed for 80 **OR** 115 **OR** 150, **as directed**, deg C rise above 40 deg C ambient.
    - e. Output Impedance: 3.5 plus or minus 0.5 percent.
    - f. Regulation: 2 to 4 percent maximum, at full-resistive load; 5 percent maximum, at rated nonlinear load.
    - g. Taps: 6 full-capacity compensation taps at 2.5 percent increments; 2 above and 4 below nominal voltage.
    - h. Full-Load Efficiency: Minimum 96 percent at rated nonlinear, **as directed**, load.
    - i. Magnetic-Field Strength External to Transformer Enclosure: Less than 0.1 gauss at 450 mm.
    - j. Audible Noise: Comply with NEMA ST 20.
    - k. Electrostatic Shielding: Independently shield each winding with a double-copper, electrostatic shield arranged to minimize interwinding capacitance.
      - 1) Coil leads and terminal trips shall be arranged to minimize capacitive coupling between input and output connections.
      - 2) Shield Terminal: Separate, and marked "Shield" for grounding connection.
      - 3) Capacitance: Limit capacitance between primary and secondary windings to a maximum of 33 picofarads over a frequency range of 20 Hz to 1 MHz.
      - 4) Common-Mode Noise Attenuation: 120 dB minimum, 0.5 to 1.5 kHz; minus 65 dB minimum, 1.5 to 100 kHz.
      - 5) Normal-Mode Noise Attenuation: Minus 52 dB minimum, 1.5 to 10 kHz.
    - l. Neutral Rating: 1.732 times the system full-load ampere rating.
- D. TVSS System
1. Description: Integrated TVSS system complying with Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits", to protect unit panelboard, and having the following features:



- a. Disconnect Device: Manual, three-pole, fused disconnect switch to de-energize TVSS system while permitting power distribution units to continue operation. Fuses are rated at 200-kA interrupting capacity.
  - b. Nonlinear Loading: System shall accommodate rated-load current with a minimum 3.0 crest factor and 85 percent total harmonic distortion.
- E. Output Panelboards
1. Description: Panelboards complying with Division 26 Section "Panelboards", except for mounting provisions. Mount in front of power distribution units behind flush doors. Include the following features:
    - a. Construction: 42 pole, 240 V, 3 phase; capable of accepting branch circuit breakers rated to 100 A.
    - b. Panelboard Rating: 225 A, with main circuit breaker.
    - c. Panelboard Phase, Neutral and Ground Buses: Copper, with neutral bus at least 1.732 times the nominal phase bus rating.
    - d. Isolated Ground Bus: Copper, adequate for branch-circuit equipment ground conductors; insulated from supports.
    - e. Branch Circuit Breakers: Bolt **OR** Plug, **as directed**, on.
    - f. Cable Racks: Removable and arranged for supporting and routing cables for panelboard entrance.
    - g. Access Panels: Arranged so additional branch-circuit wiring can be installed and connected in the future.
- F. Power Distribution Unit Controls
1. Include the following control features:
    - a. Emergency, power-off switch integral with power distribution unit.
    - b. Emergency, power-off input terminals for connection to remote power-off switch.
    - c. Over-under alarm shutdown with automatic unit disconnection for the following alarm conditions:
      - 1) High temperature.
      - 2) High and low input or output voltage.
      - 3) Phase loss.
      - 4) Ground fault.
      - 5) Reverse phase rotation.
    - d. Ground-fault protection with automatic system shutdown.
    - e. Alarm Contacts: Electrically isolated, Form C (one normally open and one normally closed), summary alarm; contact set shall change state if any monitored function goes into alarm mode.
    - f. Remote Power-Off Control: Control circuit with connection to shunt trip of power distribution unit main power circuit breaker and terminals for connection to one or more remote power-off, push-button stations.
- G. Monitoring, Status, And Alarm Annunciation
1. Description: Microprocessor-based monitoring, status, and alarm annunciation panel mounted flush in front of power distribution unit to provide status display and failure-indicating interface for the following:
    - a. Power Monitoring:
      - 1) Input Voltage: Line to line, rms.
      - 2) Output Voltage: Line to line, rms.
      - 3) Output Voltage: Line to neutral, rms.
      - 4) Output current.
    - b. Status Indication: Unit on.
    - c. Alarm Annunciation:
      - 1) High temperature.
      - 2) High and low input voltage.
      - 3) High and low output voltage.



- 4) Phase loss.
  - 5) Ground fault.
  - 6) Frequency.
  - 7) Phase rotation.
  - 8) TVSS module failure.
- d. Audible Alarm and Silencing Switch: Alarm sounds when alarm indication occurs. Silencing switch shall silence audible alarm but leave visual indication active until failure or other alarm conditions are corrected.

#### H. Sound Level

1. General: Fully assembled products comply with minimum sound-level requirements in NEMA ST 20 for transformers of corresponding ratings when factory tested according to IEEE C57.12.91.
2. General: Fully assembled products have a minimum of 3 dB less than the maximum sound levels prescribed for transformers of corresponding ratings when factory tested according to IEEE C57.12.91.

#### I. Finishes

1. Manufacturer's standard finish over corrosion-resistant pretreatment and primer.

#### J. Source Quality Control

1. Factory Tests: Design and routine tests shall comply with referenced standards.
2. Factory Sound-Level Tests: Conduct sound-level tests on equipment. Comply with IEEE C57.12.91 and NEMA ST 20.

### 1.3 EXECUTION

#### A. Installation

1. Arrange power distribution units to provide adequate access to equipment and circulation of cooling air.
2. Anchor or restrain floor-mounting power distribution units according to manufacturer's written instructions, seismic codes applicable to Project, **as directed**, and requirements in Division 26 Section "Hangers And Supports For Electrical Systems".
3. Identify equipment and install warning signs according to Division 26 Section "Identification For Electrical Systems".

#### B. Connections

1. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
  - a. Separately Derived Systems: Make grounding connections to grounding electrodes as indicated; comply with NFPA 70.
2. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

#### C. Field Quality Control

1. Perform tests and inspections and prepare test reports.
2. Tests and Inspections:
  - a. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification for circuit breakers, molded case; and for transformers, dry type, air cooled, low voltage, small. Certify compliance with test parameters.
  - b. Perform functional tests of power distribution units throughout their operating ranges. Test each monitoring, status, and alarm function.
  - c. Infrared Scanning: Two months after Final Completion, perform an infrared scan of conductor and bus connections.



- 1) Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
  - 2) Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Final Completion.
  - 3) Prepare a certified report identifying connections checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
3. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

D. Adjusting

1. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
2. Adjust power distribution units to provide optimum voltage to equipment served throughout normal operating cycle of loads served. Record input and output voltages and adjustment settings, and incorporate into test results.

E. Cleaning

1. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 24 19 00a



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 24 19 00	01 22 16 00	No Specification Required
26 24 19 00	26 09 23 00b	Electrical Power Monitoring And Control
26 24 19 00	26 11 16 00	Switchgear
26 24 19 00	26 09 23 00c	Motor-Control Centers



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**SECTION 26 25 00 00 - ENCLOSED BUS ASSEMBLIES**

## 1.1 GENERAL

## A. Description Of Work

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

## B. Summary

1. This Section includes the following:
  - a. Feeder-bus assemblies.
  - b. Plug-in bus assemblies.
  - c. Bus plug-in devices.

## C. Definitions

1. TVSS: Transient voltage surge suppressor.

## D. Submittals

1. Shop Drawings: For each type of bus assembly **OR** bus assembly and plug-in device, **as directed**.
  - a. Show fabrication and installation details for enclosed bus assemblies. Include plans, elevations, and sections of components. Designate components and accessories, including clamps, brackets, hanger rods, connectors, straight lengths, and fittings.
  - b. Show fittings, materials, fabrication, and installation methods for listed fire-stop barriers and weather barriers.
  - c. Indicate required clearances, method of field assembly, and location and size of each field connection.
  - d. Detail connections to switchgear, switchboards, transformers, and panelboards.
  - e. Wiring Diagrams: Power and signal **OR** and control, **OR** signal, and control, **as directed**, wiring.
  - f. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer.
    - 1) Design Calculations: Calculate requirements for selecting seismic restraints.
    - 2) Detail fabrication, including anchorages and attachments to structure and to supported equipment.
2. Coordination Drawings: Floor plans and sections, drawn to scale. Include scaled bus-assembly layouts and relationships between components and adjacent structural, mechanical, and electrical elements. Show the following:
  - a. Vertical and horizontal enclosed bus-assembly runs, offsets, and transitions.
  - b. Clearances for access above and to the side of enclosed bus assemblies.
  - c. Vertical elevation of enclosed bus assemblies above the floor or bottom of structure.
  - d. Support locations, type of support, and weight on each support.
3. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.
4. Product Certificates: For each type of enclosed bus assembly, signed by product manufacturer.
5. Manufacturer Seismic Qualification Certification: Submit certification that enclosed bus assemblies, plug-in devices, accessories, and components will withstand seismic forces defined in Division 26 Section "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 unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."



- 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."
  - 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. Field quality-control test reports.
8. Operation and Maintenance Data: For enclosed bus assemblies to include in emergency, operation, and maintenance manuals.

#### E. Quality Assurance

1. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
  - a. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 1.3.
2. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
3. Source Limitations: Obtain enclosed bus assemblies and plug-in devices through one source from a single manufacturer.
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. Comply with NEMA BU 1, "Busways."
6. Comply with NFPA 70.

#### F. Delivery, Storage, And Handling

1. Deliver, store, and handle enclosed bus assemblies according to NEMA BU 1.1, "General Instructions for Proper Handling, Installation, Operation and Maintenance of Busway Rated 600 Volts or Less."

#### G. Project Conditions

1. Derate enclosed bus assemblies for continuous operation at indicated ampere ratings for ambient temperature not exceeding 122 deg F (50 deg C) **OR** 140 deg F (60 deg C), **as directed**.

#### H. Coordination

1. Coordinate layout and installation of enclosed bus assemblies and suspension system with other construction that penetrates ceilings or floors or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
2. Coordinate size and location of concrete curbs around openings for vertical bus. Concrete, reinforcement, and formwork requirements are specified in Division 31.

## 1.2 PRODUCTS

#### A. Enclosed Bus Assemblies

1. Feeder-Bus Assemblies: NEMA BU 1, low-impedance bus assemblies in nonventilated housing; single-bolt joints; ratings as indicated.
  - a. Seismic Fabrication Requirements: Fabricate mounting provisions and attachments for feeder-bus assemblies with reinforcement strong enough to withstand seismic forces



- defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems" when mounting provisions and attachments are anchored to building structure
- b. Voltage: 120/208 **OR** 240 **OR** 480 **OR** 277/480, **as directed**, V; 3 phase; 100 **OR** 200 **OR** percent neutral capacity, **as directed**.
  - c. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.
  - d. Bus Materials: Current-carrying copper **OR** aluminum, **as directed**, conductors, fully insulated with Class 130C insulation except at joints; plated surface at joints.
  - e. Ground:
    - 1) 50 percent capacity integral with housing.
    - 2) 50 percent capacity internal bus bars of material matching bus material.
    - 3) 50 percent capacity isolated, internal bus bar of material matching bus material.
  - f. Enclosure: Steel with manufacturer's standard finish **OR** Aluminum with manufacturer's standard finish **OR** Weatherproof, steel or aluminum with manufacturer's standard finish, sealed seams, drains, and removable closures, **as directed**.
  - g. Fittings and Accessories: Manufacturer's standard.
  - h. Mounting: Arranged flat, edgewise, or vertically without derating.
2. Plug-in Bus Assemblies: NEMA BU 1, low-impedance bus assemblies in nonventilated housing; single-bolt joints; ratings as indicated.
- a. Seismic Fabrication Requirements: Fabricate mounting provisions and attachments for switchboards with reinforcement strong enough to withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems" when mounting provisions and attachments are anchored to building structure.
  - b. Voltage: 120/208 **OR** 240 **OR** 480 **OR** 277/480, **as directed**, V; 3 phase; 100 **OR** 200 **OR** percent neutral capacity, **as directed**.
  - c. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.
  - d. Bus Materials: Current-carrying copper **OR** aluminum, **as directed**, conductors, fully insulated with Class 130C insulation except at stabs and joints; plated surface at stabs and joints.
  - e. Ground:
    - 1) 50 percent capacity integral with housing.
    - 2) 50 percent capacity internal bus bar of material matching bus material.
    - 3) 50 percent capacity isolated, internal bus bar of material matching bus material.
  - f. Enclosure: Steel, with manufacturer's standard finish, plug-in openings 24 inches (610 mm) o.c., and hinged covers over unused openings **OR** Aluminum, with manufacturer's standard finish, plug-in openings 24 inches (610 mm) o.c., and hinged covers over unused openings, **as directed**.
  - g. Fittings and Accessories: Manufacturer's standard.
  - h. Mounting: Arranged flat, edgewise, or vertically without derating.
- B. Plug-In Devices
1. Fusible Switches: NEMA KS 1, heavy duty; with R-type rejection **OR** J-type **OR** L-type, **as directed**, fuse clips to accommodate specified fuses; hookstick-operated handle, lockable with two padlocks, and interlocked with cover in closed position. See Division 16 Section "Fuses" for fuses and fuse installation requirements.
  2. Molded-Case Circuit Breakers: NEMA AB 1; hookstick-operated handle, lockable with two padlocks, and interlocked with cover in closed position.
  3. TVSS: NEMA 250, Type 1 enclosure with NEMA KS 1, fusible, disconnect switch and external handle to isolate TVSS from busway. TVSS product and installation requirements are specified in Division 16 Section "Transient Voltage Suppression."
  4. Motor Controllers: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
    - a. Control Circuit: 120 V; obtained from integral control power transformer, **as directed**, with a control power transformer **OR** source, **as directed**, of enough capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.



- b. Combination Controller: Factory-assembled combination controller and disconnect switch with or without overcurrent protection as indicated.
  - 1) Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with R-type rejection **OR** J-type, **as directed**, fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a nationally recognized testing laboratory (NRTL) acceptable to authorities having jurisdiction. See Division 26 Section "Fuses" for fuses and fuse installation requirements.
    - OR**
    - Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
      - OR**
      - Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- c. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic. Overload relays shall have heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
- d. Adjustable Overload Relay: Dipswitch selected for motor running overload protection with NEMA ICS 2, Class 10 **OR** Class 20 **OR** Class 30, **as directed**, tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Adjustable overload relays shall have Class II ground-fault protection with start and run delays to prevent nuisance trip on starting.
- 5. Multispeed Motor Controllers: Match controller to motor type, application, and number of speeds; include the following accessories:
  - a. Compelling relay ensures motor starts only at low speed.
  - b. Accelerating relay ensures properly timed acceleration through speeds lower than that selected.
  - c. Decelerating relay ensures automatically timed deceleration through each speed.
- 6. Accessories: Hookstick operator, adjustable to maximum extension of 14 feet (4.3 m), **as directed**.

### 1.3 EXECUTION

#### A. Installation

- 1. Support bus assemblies independent of supports for other elements such as equipment enclosures at connections to panelboards and switchboards, pipes, conduits, ceilings, and ducts.
  - 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. Design each fastener and support to carry 200 lb (90 kg) or 4 times the weight of bus assembly, whichever is greater.
  - c. Support bus assembly to prevent twisting from eccentric loading.
  - d. Support bus assembly with not less than 3/8-inch (10-mm) steel rods. Install side bracing to prevent swaying or movement of bus assembly. Modify supports after completion to eliminate strains and stresses on bus bars and housings.
  - e. Fasten supports securely to building structure according to Division 26 Section "Hangers And Supports For Electrical Systems".
- 2. Install expansion fittings at locations where bus assemblies cross building expansion joints. Install at other locations so distance between expansion fittings does not exceed manufacturer's recommended distance between fittings.
- 3. Construct rated fire-stop assemblies where bus assemblies penetrate fire-rated elements such as walls, floors, and ceilings. Seal around penetrations according to Division 07 Section "Penetration Firestopping".



4. Install weatherseal fittings and flanges where bus assemblies penetrate exterior elements such as walls or roofs. Seal around openings to make weathertight. See Division 07 Section "Joint Sealants" for materials and application.
  5. Install a concrete curb at least 4 inches (100 mm) high around bus-assembly floor penetrations.
  6. Coordinate bus-assembly terminations to equipment enclosures to ensure proper phasing, connection, and closure.
  7. Tighten bus-assembly joints with torque wrench or similar tool recommended by bus-assembly manufacturer. Tighten joints again after bus assemblies have been energized for 30 days.
  8. Install bus-assembly, plug-in units. Support connecting conduit independent of plug-in unit.
- B. Connections
1. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
  2. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
- C. Field Quality Control
1. Perform tests and inspections and prepare test reports.
  2. Tests and Inspections:
    - a. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  3. Remove and replace units that do not pass tests and inspections and retest as specified above.
  4. Infrared Scanning: Two months after Final Completion, perform an infrared scan of bus assembly including joints and plug-in units.
    - a. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
    - b. Perform 2 follow-up infrared scans of bus assembly, one at 4 months and the other at 11 months after Final Completion.
    - c. Prepare a certified report identifying bus assembly checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
  5. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.
- D. Adjusting
1. Set field-adjustable, circuit-breaker trip ranges and overload relay trip settings, **as directed**, as indicated.
- E. Cleaning
1. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- F. Protection
1. Provide final protection to ensure that moisture does not enter bus assembly.

END OF SECTION 26 25 00 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 26 00 00	26 24 19 00a	Power Distribution Units
26 27 13 00	02 84 33 00	Overhead Electrical Distribution
26 27 16 00	01 22 16 00	No Specification Required
26 27 16 00	26 05 33 16	Raceways And Boxes
26 27 16 00	26 09 23 00b	Electrical Power Monitoring And Control
26 27 16 00	26 09 23 00c	Motor-Control Centers
26 27 23 00	26 05 33 16a	Wiring Devices
26 27 26 00	01 22 16 00	No Specification Required
26 27 26 00	26 05 33 16	Raceways And Boxes
26 27 26 00	26 05 33 16a	Wiring Devices
26 27 26 00	26 09 23 00b	Electrical Power Monitoring And Control
26 27 26 00	26 24 19 00	Enclosed Controllers
26 27 73 00	26 05 33 16a	Wiring Devices



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**SECTION 26 28 13 00 - FUSES**

## 1.1 GENERAL

## A. Description Of Work

1. This specification covers the furnishing and installation of materials for fuses. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers, and motor-control centers.
  - b. Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches, fuseholders, and panelboards.
  - c. Plug-fuse adapters for use in Edison-base, plug-fuse sockets.
  - d. Spare-fuse cabinets.

## C. Submittals

1. Product Data: For each type of product indicated.
2. Operation and maintenance data.

## D. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA FU 1 for cartridge fuses.
3. Comply with NFPA 70.
4. Comply with UL 248-11 for plug fuses.

## E. Project Conditions

1. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

## 1.2 PRODUCTS

## A. Cartridge Fuses

1. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

## B. Plug Fuses

1. Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

## C. Plug-Fuse Adapters

1. Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuseholders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

## D. Spare-Fuse Cabinet

1. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
  - a. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.



- b. Finish: Gray, baked enamel.
- c. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
- d. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

### 1.3 EXECUTION

#### A. Fuse Applications

1. Cartridge Fuses:
  - a. Service Entrance: Class L, fast acting **OR** Class L, time delay **OR** Class RK1, fast acting **OR** Class RK1, time delay **OR** Class J, fast acting **OR** Class J, time delay **OR** Class T, fast acting, **as directed**.
  - b. Feeders: Class L, fast acting **OR** Class L, time delay **OR** Class RK1, fast acting **OR** Class RK1, time delay **OR** Class RK5, fast acting **OR** Class RK5, time delay **OR** Class J, fast acting **OR** Class J, time delay, **as directed**.
  - c. Motor Branch Circuits: Class RK1 **OR** Class RK5, **as directed**, time delay.
  - d. Other Branch Circuits: Class RK1, time delay **OR** Class RK5, time delay **OR** Class J, fast acting **OR** Class J, time delay, **as directed**.
  - e. Control Circuits: Class CC, fast acting **OR** time delay, **as directed**.
2. Plug Fuses:
  - a. Motor Branch Circuits: Edison-base type, dual **OR** Edison-base type, single **OR** Type S, dual **OR** Type S, single, **as directed**, -element time delay.
  - b. Other Branch Circuits: Edison-base type, single-element fast acting **OR** Edison-base type, dual-element time delay **OR** Edison-base type, single-element time delay **OR** Type S, dual-element time delay **OR** Type S, single-element time delay, **as directed**.

#### B. Installation

1. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
2. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.
3. Install spare-fuse cabinet(s).

#### C. Identification

1. Install labels complying with requirements for identification specified in Division 26 Section "Identification For Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 28 13 00	26 11 16 00	Switchgear
26 29 13 13	01 22 16 00	No Specification Required
26 29 13 13	26 24 19 00	Enclosed Controllers
26 31 00 00	01 22 16 00	No Specification Required



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## SECTION 26 32 13 13 - PACKAGED ENGINE GENERATORS

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. This Section includes packaged engine-generator sets for emergency **OR** standby, **as directed**, power supply with the following features:
  - a. Gas and Diesel engine.
  - b. Unit-mounted and Remote-mounting cooling system.
  - c. Unit-mounted and Remote-mounting control and monitoring.
  - d. Performance requirements for sensitive loads.
  - e. Load banks.
  - f. Outdoor enclosure.

#### C. Definitions

1. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
2. LP: Liquid petroleum.

#### D. Submittals

1. Product Data: For each type of packaged engine generator and accessory indicated.
2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Manufacturer Seismic Qualification Certification: Submit certification that day tank, engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
4. Source quality-control test reports.
5. Field quality-control test reports.
6. Operation and maintenance data.
7. Warranty: Special warranty specified in this Section.

#### E. Quality Assurance

1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles (321 km) of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
4. Comply with ASME B15.1.
5. Comply with NFPA 37.
6. Comply with NFPA 70.
7. Comply with NFPA 99 for healthcare facilities.
8. Comply with NFPA 110 requirements for Level 1 **OR** 2, **as directed**, emergency power supply system.



9. Comply with UL 2200.
10. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
11. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

F. Project Conditions

1. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
  - a. Ambient Temperature: 5 to 40 deg C **OR** Minus 15 to plus 40 deg C, **as directed**.
  - b. Relative Humidity: 0 to 95 percent for outdoor units.
  - c. Altitude: Sea level to 1000 feet (300 m).
2. Unusual Service Conditions: Engine-generator equipment and installation are required to operate under the following conditions:
  - a. High salt-dust content in the air due to sea-spray evaporation.

## 1.2 PRODUCTS

A. Engine-Generator Set

1. Factory-assembled and -tested, engine-generator set.
2. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
  - a. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
3. Capacities and Characteristics:
  - a. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
  - b. Output Connections: Three-phase, three **OR** four, **as directed**, wire.
  - c. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
4. Generator-Set Performance:
  - a. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
  - b. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
  - c. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
  - d. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
  - e. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
  - f. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
  - g. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
  - h. Start Time: Comply with NFPA 110, Type 10, system requirements.



5. Generator-Set Performance for Sensitive Loads:
  - a. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
    - 1) Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
  - b. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
  - c. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
  - d. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
  - e. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
  - f. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
  - g. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
  - h. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
  - i. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
    - 1) Provide permanent magnet excitation for power source to voltage regulator.
  - j. Start Time: Comply with NFPA 110, Type 10, system requirements.

B. Engine

1. Fuel: Fuel oil, Grade DF-2 **OR** Natural gas with automatic LP-gas standby **OR** Natural gas, **as directed**.
2. Rated Engine Speed: 1800 rpm.
3. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).
4. Lubrication System: The following items are mounted on engine or skid:
  - a. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
  - b. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
  - c. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
5. Engine Fuel System:
  - a. Main Fuel Pump For Diesel-Fueled Engine: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
  - b. Relief-Bypass Valve For Diesel-Fueled Engine: Automatically regulates pressure in fuel line and returns excess fuel to source.
  - c. Dual Natural Gas with LP-Gas Backup (Vapor-Withdrawal) System:
    - 1) Carburetor.
    - 2) Secondary Gas Regulators: One for each fuel type.
    - 3) Fuel-Shutoff Solenoid Valves: One for each fuel source.
    - 4) Flexible Fuel Connectors: One for each fuel source.
6. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
7. Governor: Adjustable isochronous, with speed sensing.



8. Cooling System:
  - a. Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
    - 1) Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
    - 2) Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
    - 3) Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
    - 4) Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
    - 5) Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
      - a) Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
      - b) End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
  - b. Closed loop, liquid cooled, with remote radiator and integral engine-driven coolant pump.
    - 1) Configuration: Vertical **OR** Horizontal, **as directed**, air discharge.
    - 2) Radiator Core Tubes: Aluminum **OR** Nonferrous-metal construction other than aluminum, **as directed**.
    - 3) Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
    - 4) Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
    - 5) Fan: Driven by multiple belts from engine shaft **OR** totally enclosed electric motor with sealed bearings, **as directed**.
    - 6) Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
    - 7) Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
9. Muffler/Silencer:
  - a. Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
    - 1) Minimum sound attenuation of 25 dB at 500 Hz.
    - 2) Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 85 dBA or less.
  - b. Residential type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
    - 1) Minimum sound attenuation of 18 dB at 500 Hz.
    - 2) Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 95 dBA or less.
  - c. Industrial type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
    - 1) Minimum sound attenuation of 12 dB at 500 Hz.
    - 2) Sound level measured at a distance of 25 feet (8 m) from exhaust discharge after installation is complete shall be 87 dBA or less.
10. Air-Intake Filter: Standard **OR** Heavy, **as directed**, -duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
11. Starting System: 12 **OR** 24, **as directed**, -V electric, with negative ground.



- a. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
- b. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
- c. Cranking Cycle: As required by NFPA 110 for system level specified **OR** 60 seconds, **as directed**.
- d. Battery: Adequate capacity within ambient temperature range specified in Part 1.1 "Project Conditions" Article to provide specified cranking cycle at least twice **OR** three times, **as directed**, without recharging.
- e. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
- f. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1.1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
- g. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
- h. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236.
  - 1) Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
  - 2) Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
  - 3) Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
  - 4) Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
  - 5) Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
  - 6) Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

#### C. Fuel Oil Storage

1. Comply with NFPA 30.
2. Day Tank: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:
  - a. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.
    - 1) Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.
  - b. Tank Capacity: As recommended by engine manufacturer for an uninterrupted period of 4 hours' operation at 100 percent of rated power output of engine-generator system without being refilled.
  - c. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
  - d. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
  - e. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.



- f. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.
- g. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine-generator set.
- 3. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
  - a. Tank level indicator.
  - b. Capacity: Fuel for eight hours' continuous operation at 100 percent rated power output.
  - c. Vandal-resistant fill cap.
  - d. Containment Provisions: Comply with requirements of authorities having jurisdiction.

#### D. Control And Monitoring

- 1. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.
- 2. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.
- 3. Configuration:
  - a. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
  - b. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel.
  - c. Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel features shall include the following:
    - 1) Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6. Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
    - 2) Switchboard Construction: Freestanding unit complying with Division 26 Section "Switchboards".
    - 3) Switchgear Construction: Freestanding unit complying with Division 26 Section "Low-voltage Switchgear".
    - 4) Current and Potential Transformers: Instrument accuracy class.
- 4. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 **OR 2, as directed**, system, and the following:
  - a. AC voltmeter.
  - b. AC ammeter.
  - c. AC frequency meter.
  - d. DC voltmeter (alternator battery charging).
  - e. Engine-coolant temperature gage.
  - f. Engine lubricating-oil pressure gage.
  - g. Running-time meter.
  - h. Ammeter-voltmeter, phase-selector switch(es).



- i. Generator-voltage adjusting rheostat.
- j. Fuel tank derangement alarm.
- k. Fuel tank high-level shutdown of fuel supply alarm.
- l. Generator overload.
5. Indicating and Protective Devices and Controls:
  - a. AC voltmeter.
  - b. AC ammeter.
  - c. AC frequency meter.
  - d. DC voltmeter (alternator battery charging).
  - e. Engine-coolant temperature gage.
  - f. Engine lubricating-oil pressure gage.
  - g. Running-time meter.
  - h. Ammeter-voltmeter, phase-selector switch(es).
  - i. Generator-voltage adjusting rheostat.
  - j. Start-stop switch.
  - k. Overspeed shutdown device.
  - l. Coolant high-temperature shutdown device.
  - m. Coolant low-level shutdown device.
  - n. Oil low-pressure shutdown device.
  - o. Fuel tank derangement alarm.
  - p. Fuel tank high-level shutdown of fuel supply alarm.
  - q. Generator overload.
6. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
7. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 Section "Electrical Power Monitoring And Control".
8. Common Remote Audible Alarm:
  - a. Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
    - 1) Overcrank shutdown.
    - 2) Coolant low-temperature alarm.
    - 3) Control switch not in auto position.
    - 4) Battery-charger malfunction alarm.
    - 5) Battery low-voltage alarm.
  - b. Common Remote Audible Alarm for manually starting systems or for automatically starting systems not specified to comply with NFPA 110, Level 1, but where some remote alarm functions are needed. Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
    - 1) Engine high-temperature shutdown.
    - 2) Lube-oil, low-pressure shutdown.
    - 3) Overspeed shutdown.
    - 4) Remote emergency-stop shutdown.
    - 5) Engine high-temperature prealarm.
    - 6) Lube-oil, low-pressure prealarm.
    - 7) Fuel tank, low-fuel level.
    - 8) Low coolant level.
9. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.



10. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

E. Generator Overcurrent And Fault Protection

1. Generator Circuit Breaker:
  - a. Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.
    - 1) Tripping Characteristic: Designed specifically for generator protection.
    - 2) Trip Rating: Matched to generator rating.
    - 3) Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
    - 4) Mounting: Adjacent to or integrated with control and monitoring panel.
  - b. Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
    - 1) Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
    - 2) Trip Settings: Selected to coordinate with generator thermal damage curve.
    - 3) Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
    - 4) Mounting: Adjacent to or integrated with control and monitoring panel.
  - c. Insulated-case, electronic-trip type; 100 percent rated; complying with UL 489.
  - d. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
  - e. Trip Settings: Selected to coordinate with generator thermal damage curve.
  - f. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
  - g. Mounting: Adjacent to or integrated with control and monitoring panel.
2. Generator Disconnect Switch: Molded-case type, 100 percent rated.
  - a. Rating: Matched to generator output rating.
  - b. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.
3. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
  - a. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
  - b. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
  - c. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
  - d. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.
  - e. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

F. Generator, Exciter, And Voltage Regulator

1. Comply with NEMA MG 1.
2. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
3. Electrical Insulation: Class H or Class F.
4. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.



5. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
6. Enclosure: Dripproof.
7. Instrument Transformers: Mounted within generator enclosure.
8. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
  - a. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
9. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
10. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
11. Subtransient Reactance: 12 percent, maximum.

#### G. Load Bank

1. Description: Permanent, outdoor, weatherproof, remote-controlled, forced-air-cooled, resistive **OR** resistive and reactive, **as directed**, unit capable of providing a balanced 3-phase, delta-connected load to generator set at 100 percent rated-system capacity, at 80 percent power factor, lagging. Unit may be composed of separate resistive and reactive load banks controlled by a common control panel. Unit shall be capable of selective control of load in 25 percent steps and with minimum step changes of approximately 5 and 10 percent available.
2. Resistive Load Elements: Corrosion-resistant chromium alloy with ceramic and steel supports. Elements shall be double insulated and designed for repetitive on-off cycling. Elements shall be mounted in removable aluminized-steel heater cases.
3. Reactive Load Elements: Epoxy-encapsulated reactor coils.
4. Load-Bank Heat Dissipation: Integral fan with totally enclosed motor shall provide uniform cooling airflow through load elements. Airflow and coil operating current shall be such that, at maximum load, with ambient temperature at the upper end of specified range, load-bank elements operate at not more than 50 percent of maximum continuous temperature rating of resistance elements.
5. Load Element Switching: Remote-controlled contactors switch groups of load elements. Contactor coils are rated 120 V. Contactors shall be located in a separate NEMA 250, Type 3R enclosure within load-bank enclosure, accessible from exterior through hinged doors with tumbler locks.
6. Contactor Enclosures: Heated by thermostatically controlled strip heaters to prevent condensation.
7. Load-Bank Enclosures: NEMA 250, Type 3R, complying with NEMA ICS 6. Louvers at cooling-air intake and discharge openings shall prevent entry of rain and snow. Openings for airflow shall be screened with 1/2-inch- (13-mm-) square, galvanized-steel mesh. Reactive load bank shall include automatic shutters at air intake and discharge.
8. Protective Devices: Power input circuits to load banks shall be fused, and fuses shall be selected to coordinate with generator circuit breaker. Fuse blocks shall be located in contactor enclosure. Cooling airflow and overtemperature sensors shall automatically shut down and lock out load bank until manually reset. Safety interlocks on access panels and doors shall disconnect load power, control, and heater circuits. Fan motor shall be separately protected by overload and short-circuit devices. Short-circuit devices shall be noninterchangeable fuses with 200,000-A interrupting capacity.
9. Remote-Control Panel: Separate from load bank in NEMA 250, Type 1 enclosure with a control power switch and pilot light, and switches controlling groups of load elements.
10. Control Sequence: Control panel may be preset for adjustable single-step loading of generator during automatic exercising.

#### H. Outdoor Generator-Set Enclosure

1. Description:
  - a. Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.



- b. Prefabricated or preengineered walk-in enclosure with the following features:
    - 1) Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation.
    - 2) Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
    - 3) Space Heater: Thermostatically controlled and sized to prevent condensation.
    - 4) Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
    - 5) Hinged Doors: With padlocking provisions.
    - 6) Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
    - 7) Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
    - 8) Muffler Location: Within **OR** External to, **as directed**, enclosure.
  2. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
    - a. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
    - b. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
  3. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
    - a. AC lighting system and connection point for operation when remote source is available.
    - b. DC lighting system for operation when remote source and generator are both unavailable.
  4. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.
- I. Motors
1. General requirements for motors are specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
    - a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
    - b. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 22.
- J. Vibration Isolation Devices
1. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
    - a. Material: Standard neoprene **OR** Natural rubber **OR** Bridge-bearing neoprene, complying with AASHTO M 251, **as directed**.
    - b. Durometer Rating: 30 **OR** 40 **OR** 45 **OR** 50 **OR** 60 **OR** 65 **OR** 70, **as directed**.
    - c. Number of Layers: One **OR** Two **OR** Three **OR** Four, **as directed**.
  2. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
    - a. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
    - b. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
    - c. Minimum Additional Travel: 50 percent of required deflection at rated load.
    - d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
    - e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.



- K. Finishes
  - 1. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.
- L. Source Quality Control
  - 1. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
    - a. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
    - b. Report factory test results within 10 days of completion of test.

### 1.3 EXECUTION

- A. Installation
  - 1. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
  - 2. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
  - 3. Install packaged engine generator with elastomeric isolator pads **OR** restrained spring isolators, **as directed**, having a minimum deflection of 1 inch (25 mm) on 4-inch- (100-mm-) high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
  - 4. Install remote radiator with elastomeric isolator pads **OR** restrained spring isolators, **as directed**, having a minimum deflection of 1 inch (25 mm) on concrete base on grade **OR** roof equipment supports on roof, **as directed**.
  - 5. Install Schedule 40, black steel piping with welded joints for cooling water piping between engine-generator set and heat exchanger **OR** remote radiator, **as directed**. Piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping".
  - 6. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping".
    - a. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping".
  - 7. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.
  - 8. Piping installation requirements are specified in Division 21. Drawings indicate general arrangement of piping and specialties.
  - 9. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
  - 10. Connect cooling-system water piping to engine-generator set and remote radiator **OR** heat exchanger, **as directed** with flexible connectors.
  - 11. Connect engine exhaust pipe to engine with flexible connector.
  - 12. Connect fuel piping to engines with a gate valve and union and flexible connector.
    - a. Natural-gas piping, valves, and specialties for gas distribution are specified in Division 23 Section "Facility Natural-gas Piping".
    - b. LP-gas piping, valves, and specialties for gas piping are specified in Division 23 Section "Facility Liquefied-petroleum Gas Piping".
  - 13. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
  - 14. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
  - 15. Identify system components according to Division 23 Section "Identification For Hvac Piping And Equipment" and Division 26 Section "Identification For Electrical Systems".



## B. 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. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection (except those indicated to be optional) for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - b. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
  - c. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
    - 1) Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    - 2) Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    - 3) Verify acceptance of charge for each element of the battery after discharge.
    - 4) Verify that measurements are within manufacturer's specifications.
  - d. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
  - e. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
  - f. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
  - g. Exhaust Emissions Test: Comply with applicable government test criteria.
  - h. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
  - i. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
  - j. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
3. Coordinate tests with tests for transfer switches and run them concurrently.
4. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
5. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
6. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
7. Remove and replace malfunctioning units and retest **OR** reinspect, **as directed**, as specified above.
8. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
9. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

## C. Demonstration



1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 26 32 13 13



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 32 13 19	26 32 13 13	Packaged Engine Generators
26 32 13 26	26 32 13 13	Packaged Engine Generators
26 32 29 00	26 32 13 13	Packaged Engine Generators



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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



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**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 33 53 00 - STATIC UNINTERRUPTIBLE POWER SUPPLY

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for static uninterruptible power supply. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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. Three-phase, on-line, double-conversion, static-type, UPS units with the following features:
    - 1) Surge suppression.
    - 2) Input harmonics reduction.
    - 3) Rectifier-charger.
    - 4) Inverter.
    - 5) Static bypass transfer switch.
    - 6) Battery and battery disconnect device.
    - 7) Internal and External maintenance bypass/isolation switch.
    - 8) Output isolation transformer.
    - 9) Remote UPS monitoring provisions.
    - 10) Battery monitoring.
    - 11) Remote monitoring.

#### C. Definitions

1. EMI: Electromagnetic interference.
2. LCD: Liquid-crystal display.
3. LED: Light-emitting diode.
4. PC: Personal computer.
5. THD: Total harmonic distortion.
6. UPS: Uninterruptible power supply.

#### D. Performance Requirements

1. Seismic Performance: UPS shall withstand the effects of earthquake motions determined according to ASCE/SEI 7, **as directed**.
  - 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 data on features, components, ratings, and performance.
2. Shop Drawings: For UPS. Include plans, elevations, sections, details, and attachments to other work.
  - a. 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.
  - b. Wiring Diagrams: For power, signal, and control wiring.
3. Seismic Qualification Certificates: For UPS equipment, 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.
- 4. Factory Test Reports: Comply with specified requirements.
- 5. Field quality-control reports.
- 6. Operation and maintenance data.
- 7. Warranties: Sample of special warranties.

**F. Quality Assurance**

- 1. 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.
- 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. UL Compliance: Listed and labeled under UL 1778 by an NRTL.
- 4. NFPA Compliance: Mark UPS components as suitable for installation in computer rooms according to NFPA 75.

**G. Warranty**

- 1. Special Battery Warranties: Specified form in which manufacturer and Installer agree to repair or replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.
  - a. Warranted Cycle Life for Valve-Regulated, Lead-Calcium Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.67	6 cycles
30 minutes	30 minutes	1.67	20 cycles
15 minutes	45 seconds	1.67	120 cycles

**OR**

Warranted Cycle Life for Premium Valve-Regulated, Lead-calcium Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.67	40 cycles
30 minutes	30 minutes	1.67	125 cycles
15 minutes	1.5 minutes	1.67	750 cycles

**OR**

Warranted Cycle Life for Flooded Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.75	40 cycles
1 hour	1 hour	1.75	80 cycles
15 minutes	45 seconds	1.67	2700 cycles



2. Special UPS Warranties: Specified form in which manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within Two **OR** Three, **as directed**, years from date of Final Completion.

## 1.2 PRODUCTS

### A. Operational Requirements

1. Automatic operation includes the following:
  - a. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
  - b. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to maintain constant, regulated inverter power output to the load without switching or disturbance.
  - c. If normal power fails, energy supplied by the battery through the inverter continues supply-regulated power to the load without switching or disturbance.
  - d. When power is restored at the normal supply terminals of the system, controls automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.
  - e. If the battery becomes discharged and normal supply is available, the rectifier-charger charges the battery. On reaching full charge, the rectifier-charger automatically shifts to float-charge mode.
  - f. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch switches the load to the normal ac supply circuit without disturbance or interruption.
  - g. If a fault occurs in the system supplied by the UPS, and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch operates to bypass the fault current to the normal ac supply circuit for fault clearing.
  - h. When the fault has cleared, the static bypass transfer switch returns the load to the UPS system.
  - i. If the battery is disconnected, the UPS continues to supply power to the load with no degradation of its regulation of voltage and frequency of the output bus.
2. Manual operation includes the following:
  - a. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal ac supply circuit without disturbance or interruption.
  - b. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.
3. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection among the three conditions in subparagraphs below without interrupting supply to the load during switching:
  - a. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.
  - b. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
  - c. Normal: Normal UPS ac supply terminals are energized and the load is supplied through either the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.
4. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance.
  - a. Ambient Temperature for Electronic Components: 32 to 104 deg F (0 to 40 deg C).



- b. Ambient Temperature for Battery: 41 to 95 deg F (5 to 35 deg C).
- c. Relative Humidity: 0 to 95 percent, noncondensing.
- d. Altitude: Sea level to 4000 feet (1220 m).

**B. Performance Requirements**

1. The UPS shall perform as specified in this article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a load crest factor of 3.0, under the following conditions or combinations of the following conditions:
  - a. Inverter is switched to battery source.
  - b. Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal voltage.
  - c. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
  - d. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
  - e. Load is 30 **OR** 50 **OR** 100, **as directed**, percent unbalanced continuously.
2. Minimum Duration of Supply: If battery is sole energy source supplying rated full UPS load current at 80 percent power factor, duration of supply is five **OR** 10 **OR** 15, **as directed**, minutes.
3. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10, minus 15 **OR** 20 **OR** 30, **as directed**, percent from nominal voltage.
4. Overall UPS Efficiency:

**NOMINAL OVERALL UPS EFFICIENCY RATINGS**

SIZE RANGE OF UPS UNITS	EFFICIENCY AT 100% RATED LOAD	EFFICIENCY AT 75% RATED LOAD	EFFICIENCY AT 50% RATED LOAD
30 kVA and Smaller	86	85	84
37.5 to 74 kVA	89	88	87
75 to 124 kVA	90	88	87
125 to 224 kVA	90	89	88
225 kVA and Larger	90	89	88

5. Maximum Acoustical Noise:

**NOMINAL OVERALL UPS AUDIBLE NOISE RATINGS**

SIZE RANGE OF UPS UNITS	MAXIMUM NOISE VALUE	DISTANCE AT WHICH MEASURED
10 kVA and Smaller	58 dB	36 inches (900 mm)
20 to 125 kVA	60 dB	48 inches (1200 mm)
150 to 300 kVA	78 dB	48 inches (1200 mm)
300 kVA and Larger	83 dB	48 inches (1200 mm)

6. Maximum Energizing Inrush Current: Six **OR** Eight, **as directed**, times the full-load current.
7. Maximum AC Output-Voltage Regulation for Loads up to 50 Percent Unbalanced: Plus or minus 2 percent over the full range of battery voltage.
8. Output Frequency: 60 Hz, plus or minus 0.5 percent over the full range of input voltage, load, and battery voltage.
9. Limitation of harmonic distortion of input current to the UPS shall be as follows:



- a. Description: Either a tuned harmonic filter or an arrangement of rectifier-charger circuits shall limit THD to 5 **OR** 10, **as directed**, percent, maximum, at rated full UPS load current, for power sources with X/R ratio between 2 and 30.  
**OR**  
Description: THD is limited to a maximum of 32 percent, at rated full UPS load current, for power sources with X/R ratio between 2 and 30.
10. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent rms total and 3 percent rms for any single harmonic, for 100 percent rated nonlinear load current with a load crest factor of 3.0.  
**OR**  
Maximum Harmonic Content of Output-Voltage Waveform: 5 percent rms total and 3 percent rms for any single harmonic, for rated full load with THD up to 50 percent, with a load crest factor of 3.0.
11. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 minutes, and 150 percent for 30 seconds in all operating modes.
12. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 100 ms:
  - a. 50 Percent: Plus or minus 5 percent.
  - b. 100 Percent: Plus or minus 5 percent.
  - c. Loss of AC Input Power: Plus or minus 1 percent.
  - d. Restoration of AC Input Power: Plus or minus 1 percent.
13. Input Power Factor: A minimum of 0.70 **OR** 0.85, **as directed**, lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current.
14. EMI Emissions: Comply with FCC Rules and Regulations and with 47 CFR 15 for Class A equipment.

### C. UPS Systems

1. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.
2. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.
3. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.
4. Surge Suppression: Protect internal UPS components from surges that enter at each ac power input connection including main disconnect switch, static bypass transfer switch, and maintenance bypass/isolation switch, **as directed**. Protect rectifier-charger, inverter, controls, and output components.
  - a. Use factory-installed surge suppressors tested according to IEEE C62.41.1 and IEEE C62.41.2, Category B **OR** Category C, **as directed**.
  - b. Additional Surge Protection: Protect internal UPS components from low-frequency, high-energy voltage surges described in IEEE C62.41.1 and IEEE C62.41.2. Design the circuits connecting with external power sources and select circuit elements, conductors, conventional surge suppressors, and rectifier components and controls so input assemblies will have adequate mechanical strength and thermal and current-carrying capacity to withstand stresses imposed by 40-Hz, 180 percent voltage surges described in IEEE C62.41.1 and IEEE C62.41.2.
5. Maintainability Features (for units rated more than approximately 100 kVA): Mount rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins, readily accessible for maintenance.
6. Capacity Upgrade Capability: Arrange wiring, controls, and modular component plug-in provisions to permit future 25 percent increase in UPS capacity.
7. Seismic-Restraint Design: UPS assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces.
8. UPS Cabinet Ventilation: Redundant fans or blowers draw in ambient air near the bottom of cabinet and discharge it near the top rear.



- 9. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity (for a UPS with heavy nonlinear loading): Rated phase current times a multiple of 1.73, minimum.

D. Rectifier-Charger

- 1. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.
- 2. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.
- 3. Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.
  - a. Response Time: Field adjustable for maximum compatibility with local generator-set power source.
- 4. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life.

E. Inverter

- 1. Description: Pulse-width modulated, with sinusoidal output.  
**OR**  
 Description (if the UPS may be supplied power from a standby engine-generator set): Pulse-width modulated, with sinusoidal output. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.

F. Static Bypass Transfer Switch

- 1. Description: Solid-state switching device providing uninterrupted transfer. A contactor or electrically operated circuit breaker automatically provides electrical isolation for the switch.
- 2. Switch Rating: Continuous duty at the rated full UPS load current, minimum.

G. Battery

**ALTERNATIVE BATTERY TYPES FOR UPS SYSTEMS**

TYPE	NOMINAL LIFE EXPECTANCY (YEARS)*	TYPICAL WARRANTY (YEARS)*		MINIMUM NOMINAL MAINTENANCE INTERVAL	APPROX. INITIAL COST FACTOR**	SPECIAL FEATURES
		FULL	PRO RATA			
Premium quality, valve regulated, recombinant, lead calcium	20	1	19	1 year	2.5	Spill proof.
Standard quality, valve regulated, recombinant, lead calcium	10	1	9	1 year	1.0	Spill proof.
Nickel cadmium, flooded	25	5	15	3 years	4.0	Can operate in high ambient temperatures. Can be completely discharged without damage.
Lead calcium, flooded	20	1	9	6 months	2.5	-

\*Life expectancy and warranty data apply to installations where batteries are considered to be in a "float-service"



application. Use the data only as a general guide because UPS batteries are typically considered to be in a separate service application category that accounts for the numerous discharges of varying duration they experience.

\*\*Cost includes an allowance for space requirements and environmental control.

1. Description: Valve-regulated, recombinant, lead-calcium units, factory assembled in an isolated compartment of UPS cabinet, complete with battery disconnect switch.
  - a. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

**OR**

Description: Valve-regulated, premium, heavy-duty, recombinant, lead-calcium units; factory assembled in an isolated compartment or in a separate matching cabinet, complete with battery disconnect switch.

  - a. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

**OR**

Description: Flooded, lead-calcium, heavy-duty industrial units in styrene acrylonitrile containers mounted on three-tier, **as directed**, acid-resistant, painted steel racks. Assembly includes battery disconnect switch, intercell connectors, hydrometer syringe, and thermometer with specific gravity-correction scales.
2. Seismic-Restraint Design: Battery racks, cabinets, assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them) shall be designed and fabricated to withstand static and seismic forces.

#### H. Controls And Indications

1. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.
2. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.
3. Indications: Labeled LED **OR** Plain-language messages on a digital LCD or LED, **as directed**.
  - a. Quantitative indications shall include the following:
    - 1) Input voltage, each phase, line to line.
    - 2) Input current, each phase, line to line.
    - 3) Bypass input voltage, each phase, line to line.
    - 4) Bypass input frequency.
    - 5) System output voltage, each phase, line to line.
    - 6) System output current, each phase.
    - 7) System output frequency.
    - 8) DC bus voltage.
    - 9) Battery current and direction (charge/discharge).
    - 10) Elapsed time discharging battery.
  - b. Basic status condition indications shall include the following:
    - 1) Normal operation.
    - 2) Load-on bypass.
    - 3) Load-on battery.
    - 4) Inverter off.
    - 5) Alarm condition.
  - c. Alarm indications shall include the following:
    - 1) Bypass ac input overvoltage or undervoltage.
    - 2) Bypass ac input overfrequency or underfrequency.
    - 3) Bypass ac input and inverter out of synchronization.
    - 4) Bypass ac input wrong-phase rotation.
    - 5) Bypass ac input single-phase condition.
    - 6) Bypass ac input filter fuse blown.
    - 7) Internal frequency standard in use.
    - 8) Battery system alarm.
    - 9) Control power failure.
    - 10) Fan failure.



- 11) UPS overload.
  - 12) Battery-charging control faulty.
  - 13) Input overvoltage or undervoltage.
  - 14) Input transformer overtemperature.
  - 15) Input circuit breaker tripped.
  - 16) Input wrong-phase rotation.
  - 17) Input single-phase condition.
  - 18) Approaching end of battery operation.
  - 19) Battery undervoltage shutdown.
  - 20) Maximum battery voltage.
  - 21) Inverter fuse blown.
  - 22) Inverter transformer overtemperature.
  - 23) Inverter overtemperature.
  - 24) Static bypass transfer switch overtemperature.
  - 25) Inverter power supply fault.
  - 26) Inverter transistors out of saturation.
  - 27) Identification of faulty inverter section/leg.
  - 28) Inverter output overvoltage or undervoltage.
  - 29) UPS overload shutdown.
  - 30) Inverter current sensor fault.
  - 31) Inverter output contactor open.
  - 32) Inverter current limit.
- d. Controls shall include the following:
- 1) Inverter on-off.
  - 2) UPS 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. UPS on battery.
  - b. UPS on-line.
  - c. UPS load-on bypass.
  - d. UPS in alarm condition.
  - e. UPS off (maintenance bypass closed).
5. Emergency Power Off Switch: Capable of local operation and operation by means of activation by external dry contacts.

I. Maintenance Bypass/Isolation Switch

1. Description: Manually operated switch or arrangement of switching devices with mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.
  - a. Switch shall be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.
  - b. Switch shall electrically isolate other UPS components to permit safe servicing.
2. Comply with NEMA PB 2 and UL 891.
3. Switch Rating: Continuous duty at rated full UPS load current.
4. Mounting Provisions: Internal to system cabinet **OR** Separate wall- or floor-mounted unit, **as directed**.
5. Key interlock requires unlocking maintenance bypass/isolation switch before switching from normal position with key that is released only when the UPS is bypassed by the static bypass transfer switch. Lock is designed specifically for mechanical and electrical component interlocking.

J. Output Isolation Transformer



1. Description: Shielded unit **OR** Unit, **as directed**, with low forward transfer impedance up to 3 kHz, minimum. Include the following features:
  - a. Comply with applicable portions of UL 1561, including requirements for nonlinear load current-handling capability for a K-factor of approximately 4 **OR** 9 **OR** 13 **OR** 20, **as directed**.
  - b. Output Impedance at Fundamental Frequency: Between 3 and 4 percent.
  - c. Regulation: 5 percent, maximum, at rated nonlinear load current.
  - d. Full-Load Efficiency at Rated Nonlinear Load Current: 96 percent, minimum.
  - e. Electrostatic Shielding of Windings: Independent for each winding.
  - f. Coil Leads: Physically arranged for minimum interlead capacitance.
  - g. Shield Grounding Terminal: Separately mounted; labeled "Shield Ground."
  - h. Capacitive Coupling between Primary and Secondary: 33 picofarads, maximum, over a frequency range of 20 Hz to 1 MHz.
  
- K. Output Distribution Section
  1. Panelboards: Comply with Division 26 Section "Panelboards" except provide assembly integral to UPS cabinet.
  
- L. Monitoring By Remote Status And Alarm Panel
  1. Description: Labeled LEDs on panel faceplate 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.
  
- M. Monitoring By Remote Computer
  1. Description: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms specified in "Controls and Indications" Article. The remote computer and the connecting signal wiring are not included in this Section. Include the following features:
    - a. Connectors and network interface units or modems for data transmission via RS-232 link.
    - b. Software designed for control and monitoring of UPS functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of meaningful reports. Permit storage and analysis of power-line transient records. Designs for Windows applications, software, and computer are not included in this Section.
    - c. Software and Hardware: Compatible with that specified in Division 26 Section "Electrical Power Monitoring And Control".
  
- N. Basic Battery Monitoring
  1. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.
  2. Battery compartment smoke/high-temperature detector initiates an alarm when smoke or a temperature greater than 75 deg C occurs within the compartment.
  3. Annunciation of Alarms: At UPS control panel.
  
- O. Additional Battery Monitoring
  1. Monitoring features and components shall include the following:
    - a. Factory-wired sensing leads to cell and battery terminals and cell temperature sensors.
    - b. Connections for data transmission via RS-232 link, network interface and, **as directed**, modem and, **as directed**, external signal wiring to computer **OR** electrical power monitoring and control equipment, **as directed**. External signal wiring and computer are not specified in this Section.
    - c. PC-based software designed to store and analyze battery data. Software compiles reports on individual-cell parameters and total battery performance trends, and provides data for scheduling and prioritizing battery maintenance.



2. Performance: Automatically measures and electronically records the following parameters on a routine schedule and during battery discharge events. During discharge events, records measurements timed to nearest second; includes measurements of the following parameters:
  - a. Total battery voltage and ambient temperature.
  - b. Individual-cell voltage, impedance, and temperature. During battery-discharging events such as utility outages, measures battery and cell voltages timed to nearest second.
  - c. Individual-cell electrolyte levels.

P. Battery-Cycle Warranty Monitoring

1. Description: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring of charge-discharge cycle history of batteries covered by cycle-life warranties.
2. 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 front panel display.
3. Additional monitoring functions and features shall include the following:
  - a. Measuring and Recording: Total voltage at battery terminals; initiates alarm for excursions outside the proper float-voltage level.
  - b. Monitors: Ambient temperature at battery; initiates alarm if temperature deviates from normally acceptable range.
  - c. Keypad on Device Front Panel: Provides access to monitored data using front panel display.
  - d. Alarm Contacts: Arranged to initiate local **OR** remote, **as directed**, alarm for battery discharge events **OR** abnormal temperature **OR** abnormal battery voltage or temperature, **as directed**.
  - e. Memory: Stores recorded data in nonvolatile electronic memory.
  - f. RS-232 Port: Permits downloading of data to a portable PC.
  - g. Modem: Makes measurements and recorded data accessible to a remote PC via telephone line. Computer is not specified in this Section.

Q. Source Quality Control

1. Factory test complete UPS system before shipment. Use actual batteries that are part of final installation **OR** simulated battery testing, **as directed**. Include the following:
  - a. 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 opportunity for Owner's representative to observe tests at Owner's choice.
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. Equipment Mounting: Install UPS on concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
  - a. 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.



- b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - d. Install anchor bolts to elevations required for proper attachment to supported equipment.
  2. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
  3. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.
- B. Grounding
1. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer.
- C. Identification
1. Identify components and wiring according to Division 26 Section "Identification For Electrical Systems".
    - a. Identify each battery cell individually.
- D. Battery Equalization
1. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.
- 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. Comply with manufacturer's written instructions.
    - b. Inspect interiors of enclosures, including the following:
      - 1) Integrity of mechanical and electrical connections.
      - 2) Component type and labeling verification.
      - 3) Ratings of installed components.
    - c. Inspect batteries and chargers according to requirements in NETA Acceptance Testing Specifications.
    - d. Test manual and automatic operational features and system protective and alarm functions.
    - e. Test communication of status and alarms to remote monitoring equipment.
    - f. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated within the previous six months according to NIST standards.
      - 1) Simulate malfunctions to verify protective device operation.
      - 2) Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
      - 3) Test harmonic content of input and output current less than 25, 50, and 100 percent of rated loads.
      - 4) Test output voltage under specified transient-load conditions.
      - 5) Test efficiency at 50, 75, and 100 percent of rated loads.
      - 6) Test remote status and alarm panel functions.
      - 7) Test battery-monitoring system functions.
  3. Seismic-restraint tests and inspections shall include the following:
    - a. Inspect type, size, quantity, arrangement, and proper installation of mounting or anchorage devices.



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- b. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
  - 4. The UPS system will be considered defective if it does not pass tests and inspections.
  - 5. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.
  - 6. Prepare test and inspection reports.
- F. Demonstration
- 1. Train Owner's maintenance personnel to adjust, operate, and maintain the UPS.

END OF SECTION 26 33 53 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 33 53 00	26 33 43 00	Central Battery Inverters

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## SECTION 26 35 33 00 - POWER FACTOR CORRECTION CAPACITORS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for power factor correction capacitors. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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 power and automatic power factor correction equipment rated 600 V and less.

#### C. Performance Requirements

1. Seismic Performance: Power factor correction equipment 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."

#### D. Submittals

1. Product Data: For each type of product indicated. Include dimensions, operating characteristics of multiple capacitor cells or elements, and data on features, ratings, and performance.
2. Shop Drawings: For automatic power factor correction units.
  - a. Detail equipment assemblies and indicate dimensions, weights, method of field assembly, components, and location and size of each field connection. Show access and workspace requirements and required clearances.
  - b. Wiring Diagrams: For power, signal, and control wiring.
3. Qualification Data: For qualified testing agency.
4. Seismic Qualification Certificates: For capacitors, accessories, and components, from manufacturer.
  - a. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - b. Dimensioned Outline Drawings of Equipment: 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: For equipment to include in emergency, operation, and maintenance manuals. Include the following:
  - a. Lists of spare parts and replacement components recommended for storage at Project site.
  - b. Detailed instructions covering operation under both normal and abnormal conditions.
7. Warranty: Sample of special warranty.

#### E. Quality Assurance

1. 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.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with IEEE 18 and NEMA CP 1.
4. Comply with NFPA 70.

#### F. Coordination



1. Coordinate sensor-communication module package with data network and with monitoring equipment specified in Division 26 Section "Electrical Power Monitoring And Control" for successful transmission and remote readout of remote monitoring data specified in this Section.

G. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace capacitor-bank components that fail in materials or workmanship within five years from date of Final Completion.

## 1.2 PRODUCTS

A. Capacitors, General

1. Comply with UL 810.
2. Service Conditions: Capacitor equipment suitable for the following conditions:
  - a. Operating Temperature: Minus 40 to plus 115 deg F (Minus 40 to plus 46 deg C).
  - b. Maximum Altitude: 6000 feet (1800 m).
  - c. Humidity: 0 to 95 percent, noncondensing.
3. Construction: Multiple capacitor cells or elements, factory wired in three-phase groups and mounted in metal enclosures.
4. Cells: Dry metallized-dielectric, self-healing type. Each cell shall be encapsulated in thermosetting resin inside plastic container.
5. Rupture Protection: Pressure-sensitive circuit interrupter for each cell.

B. Fixed Capacitors

1. Description: Factory wired, ready for field connection to external circuits at a single set of pressure terminals. Comply with UL 810.
2. Fuses: Current-limiting, noninterchangeable type; factory installed in each phase and located within the equipment enclosure. Features include the following:
  - a. Interrupting Capacity: 100,000 **OR** 200,000, **as directed**, A
  - b. Fuse Ratings and Characteristics: As recommended by capacitor manufacturer.
  - c. Neon Indicator Lamp for Each Fuse: Connect to illuminate when fuse has opened, but is still in place, and locate so it is visible from outside the enclosure.
3. Discharge Resistors: Factory installed and wired.
4. Enclosure: NEMA 250, steel **OR** aluminum, **as directed**, arranged to contain the fluid leakage from capacitor cells; factory equipped with mounting brackets suitable for type of mounting indicated.
  - a. Indoor Enclosures: NEMA 250, Type 12 or as indicated.  
**OR**  
Outdoor Enclosures: NEMA 250, Type 3R or as indicated.  
**OR**  
Outdoor Enclosures: NEMA 250, Type 4, equipped with watertight conduit connections.

C. Automatic Power Factor Correction Units

1. Description: Capacitors, contactors, controls, and accessories factory installed in independent enclosures **OR** motor-control center, with a connection to motor-control center bus, **as directed**, complying with NEMA ICS 2. Comply with UL 810.
2. Performance Requirements: Controls permit selection of a target power factor, adjustable to any value between unity and 0.80 lagging. Controls continuously sense the power factor on circuits being corrected and, when the power factor differs from the target setting for more than 10 seconds, operate a contractor to switch a capacitor bank into or out of the circuit. Contactors are opened or closed as required to bring the corrected circuit power factor closer to the target setting. Provide number of switching steps indicated on the Three-Phase Capacitor-Bank Schedule.
3. Current Transformer: Type, configuration, and ratio to suit sensing and mounting conditions.



4. Main Circuit Breaker: Thermal-magnetic, inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger. Operable from outside the enclosure to disconnect the unit.
  5. Controls: Solid-state, microprocessor-based controls, including the following:
    - a. Undervoltage relay that interrupts capacitor switching and disconnects capacitors for power-supply interruptions longer than 15 minutes.
    - b. "Advance" and "Retard" push buttons on the control panel to permit manually controlled capacitor-bank switching.
  6. Contactors: Three pole; rated for the repetitive high-inrush-switching duty in the capacitor application.
  7. Fuses for Protection of Capacitor Banks: Rated to protect contactor, interconnecting wiring, and capacitors.
    - a. Spare-Fuse Cabinet: Identified and compartmented steel box **OR** cabinet with hinged lockable door, **as directed**.
  8. Discharge Resistors: Factory installed and wired.  
**OR**  
Inductors: Air-core type, connected in capacitor circuits; rated to limit switching surges to within contactor ratings.
  9. Precharge Capacitor Circuit: Resistive, precharge circuit to charge capacitors prior to switching and to limit switching surges to within contactor ratings.
  10. Enclosure: NEMA 250, Type 1 **OR** Type 3R **OR** Type 12, **as directed**, steel or aluminum, with hinged door and hand-operated catch. Door shall be interlocked with controls or main circuit breaker to de-energize capacitors when door is opened.
    - a. Factory Finish: Manufacturer's standard enamel over corrosion-resistant treatment or primer coat.
  11. Local Display: LED or liquid-crystal digital type, mounted in door of enclosure, indicating the following:
    - a. Target and actual power factors accurate to plus or minus 1 percent of reading.
    - b. Steps energized.
    - c. Step reconnection delay.
    - d. Real and reactive currents.
    - e. Voltage total harmonic distortion.
    - f. Alarm codes.
  12. System Alarms: Alarm relay and local display indication of the following conditions:
    - a. Low power factor.
    - b. Leading power factor.
    - c. Frequency not detected.
    - d. Overcurrent.
    - e. Overvoltage.
    - f. Overtemperature.
    - g. Excessive voltage total harmonic distortion.
    - h. Capacitor overload.
    - i. Loss of capacitance.
  13. Remote Monitoring Components: Sensors, associated communication modules, and network interface units, matched to and compatible with electrical power monitoring and control network. Communication module shall have capability to transmit the following data to remote monitoring devices:
    - a. System in alarm.
    - b. Power factor set point.
    - c. Corrected power factor.
    - d. Number of capacitor steps activated.
- D. Source Quality Control
1. Factory test power factor correction equipment before shipment. Comply with NEMA CP 1. Include the following:



- a. Routine capacitor production tests, including short-time overvoltage, capacitance, leak, and dissipation-factor tests.
- b. Functional test of all operations, controls, indicators, sensors, and protective devices.

### 1.3 EXECUTION

#### A. Installation

1. Install freestanding equipment on concrete bases. Cast-in-place concrete is specified in Division 3.
2. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
3. Maintain minimum workspace according to manufacturer's written instructions.
4. Connect remote monitoring communication module to electrical power monitoring and control data network through appropriate network interface unit.
5. Identify components according to Division 26 Section "Identification For Electrical Systems".

#### B. 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: Perform each visual and mechanical inspection and electrical test stated in the following Sections, except optional tests, in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - a. Current Transformers.
  - b. Capacitors and Reactors, Capacitors.

#### C. Startup Service

1. Perform startup service.
  - a. Complete installation and startup checks according to manufacturer's written instructions.
  - b. Connect and run installed motors and equipment to verify the automatic switching of the capacitors. Verification shall include automatic switching of the total capacity of installed capacitors.
    - 1) Provide sufficient inductive/reactive load banks, in combination with resistive load banks, for the test.

#### D. Demonstration

1. Train Owner's maintenance personnel to adjust, operate, and maintain automatic power factor correction units.

END OF SECTION 26 35 33 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 35 33 00	26 09 23 00b	Electrical Power Monitoring And Control
26 35 53 00	26 32 13 13	Packaged Engine Generators



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## SECTION 26 36 13 00 - TRANSFER SWITCHES

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for transfer switches. Products shall be as follows or as directed by the Owner. Installation procedures shall be 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 transfer switches rated 600 V and less, including the following:
  - a. Automatic transfer switches.
  - b. Bypass/isolation switches.
  - c. Nonautomatic transfer switches.
  - d. Remote annunciation systems.
  - e. Remote annunciation and control systems.

#### C. Submittals

1. Product Data: Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
2. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
3. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems". Include the following:
4. Field quality-control test reports.
5. 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 ICS 1.
3. Comply with NFPA 70.
4. Comply with NFPA 99.
5. Comply with NFPA 110.
6. Comply with UL 1008 unless requirements of these Specifications are stricter.

### 1.2 PRODUCTS

#### A. General Transfer-Switch Product Requirements

1. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
2. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
  - a. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
3. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.



4. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
  5. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
  6. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
    - a. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
    - b. Switch Action: Double throw; mechanically held in both directions.
    - c. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
  7. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles **OR** overlapping neutral contacts, **as directed**.
  8. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
  9. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.
  10. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.
  11. Battery Charger: For generator starting batteries.
    - a. Float type rated 2 **OR** 10, **as directed**, A.
    - b. Ammeter to display charging current.
    - c. Fused ac inputs and dc outputs.
  12. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
  13. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification For Electrical Systems".
    - a. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
    - b. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
    - c. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
  14. Enclosures: General-purpose NEMA 250, Type 1 **OR** 3R **OR** 12, **as directed**, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.
- B. Automatic Transfer Switches
1. Comply with Level 1 equipment according to NFPA 110.
  2. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
  3. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
  4. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
  5. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
  6. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
  7. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.
  8. Automatic Closed-Transition Transfer Switches: Include the following functions and characteristics:



- a. Fully automatic make-before-break operation.
  - b. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
  - c. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.
    - 1) Initiation occurs without active control of generator.
    - 2) Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.
  - d. Failure of power source serving load initiates automatic break-before-make transfer.
9. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
10. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.
11. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.
12. Automatic Transfer-Switch Features:
- a. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
  - b. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
  - c. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
  - d. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
  - e. Test Switch: Simulate normal-source failure.
  - f. Switch-Position Pilot Lights: Indicate source to which load is connected.
  - g. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
    - 1) Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    - 2) Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
  - h. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
  - i. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.



- j. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
- k. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
- l. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
- m. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
  - 1) Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
  - 2) Push-button programming control with digital display of settings.
  - 3) Integral battery operation of time switch when normal control power is not available.

#### C. Bypass/Isolation Switches

1. Comply with requirements for Level 1 equipment according to NFPA 110.
2. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:
  - a. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance.
  - b. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations.
  - c. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
  - d. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
  - e. Operability: Constructed so load bypass and transfer-switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less.
  - f. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
  - g. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.
3. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

#### D. Nonautomatic Transfer Switches

1. Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternate Source." Switch shall be capable of transferring load in either direction with either or both sources energized.
2. Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternate Source." In addition, removable manual handle provides quick-make, quick-break manual-switching action. Switch shall be capable of electrically or manually transferring load in either direction with either or both sources energized. Control circuit disconnects from electrical operator during manual operation.
3. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.



4. Nonautomatic Transfer-Switch Accessories:
  - a. Pilot Lights: Indicate source to which load is connected.
  - b. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternate-source sensing circuits.
    - 1) Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    - 2) Emergency Power Supervision: Red light with nameplate engraved "Alternate Source Available."
  - c. Unassigned Auxiliary Contacts: One set of normally closed contacts for each switch position, rated 10 A at 240-V ac.
- E. Remote Annunciator System
  1. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:
    - a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    - b. Switch position.
    - c. Switch in test mode.
    - d. Failure of communication link.
  2. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
    - a. Indicating Lights: Grouped for each transfer switch monitored.
    - b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
    - c. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
    - d. Lamp Test: Push-to-test or lamp-test switch on front panel.
- F. Remote Annunciator And Control System
  1. Functional Description: Include the following functions for indicated transfer switches:
    - a. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    - b. Indication of switch position.
    - c. Indication of switch in test mode.
    - d. Indication of failure of digital communication link.
    - e. Key-switch or user-code access to control functions of panel.
    - f. Control of switch-test initiation.
    - g. Control of switch operation in either direction.
    - h. Control of time-delay bypass for transfer to normal source.
  2. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand-alone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
  3. Remote Annunciation and Control Panel: Solid-state components. Include the following features:
    - a. Controls and indicating lights grouped together for each transfer switch.
    - b. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
    - c. Digital Communication Capability: Matched to that of transfer switches supervised.
    - d. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
- G. Source Quality Control
  1. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.



### 1.3 EXECUTION

#### A. Installation

1. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Hangers And Supports For Electrical Systems".
2. Floor-Mounting Switch: Anchor to floor by bolting.
  - a. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers And Supports For Electrical Systems".
3. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
4. Identify components according to Division 26 Section "Identification For Electrical Systems".
5. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

#### B. Connections

1. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to the Owner if necessary to accommodate required wiring.
2. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
3. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

#### C. Field Quality Control

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
2. 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 installation, including connections, and to assist in testing.
  - b. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
  - c. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - d. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    - 1) Check for electrical continuity of circuits and for short circuits.
    - 2) Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    - 3) Verify that manual transfer warnings are properly placed.
    - 4) Perform manual transfer operation.
  - e. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
    - 1) Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    - 2) Simulate loss of phase-to-ground voltage for each phase of normal source.
    - 3) Verify time-delay settings.
    - 4) Verify pickup and dropout voltages by data readout or inspection of control settings.
    - 5) Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.



- 6) Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
  - f. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
    - 1) Verify grounding connections and locations and ratings of sensors.
  3. Coordinate tests with tests of generator and run them concurrently.
  4. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
  5. Remove and replace malfunctioning units and retest as specified above.
  6. Infrared Scanning: After Final Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
    - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Final Completion.
    - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    - c. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- D. Demonstration
1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below.
  2. Coordinate this training with that for generator equipment.

END OF SECTION 26 36 13 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 36 13 00	26 24 13 00a	Enclosed Switches And Circuit Breakers
26 36 23 00	26 24 13 00a	Enclosed Switches And Circuit Breakers
26 36 23 00	26 36 13 00	Transfer Switches
26 41 13 00	26 05 26 00	Lightning Protection



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## SECTION 26 43 13 00 - TRANSIENT VOLTAGE SUPPRESSION

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. Section includes field-mounted TVSS for low-voltage (120 to 600 V) power distribution and control equipment.

#### C. Definitions

1. ATS: Acceptance Testing Specifications.
2. SVR: Suppressed voltage rating.
3. TVSS: Transient voltage surge suppressor(s), both singular and plural; also, transient voltage surge suppression.

#### D. Submittals

1. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.
2. Field quality-control reports.
3. Operation and maintenance data.
4. Warranties: Sample of special warranties.

#### E. Quality Assurance

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.
2. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.
3. Comply with NEMA LS 1.
4. Comply with UL 1283, **as directed**, and UL 1449.
5. Comply with NFPA 70.

#### F. Project Conditions

1. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
  - a. Notify Owner no fewer than two days in advance of proposed electrical service interruptions.
  - b. Do not proceed with interruption of electrical service without Owner's written permission.
2. Service Conditions: Rate TVSS devices for continuous operation under the following conditions unless otherwise indicated:
  - a. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
  - b. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
  - c. Humidity: 0 to 85 percent, noncondensing.
  - d. Altitude: Less than 20,000 feet (6090 m) above sea level.

#### G. Warranty

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



2. Special Warranty for Cord-Connected, Plug-in Surge Suppressors: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

## 1.2 PRODUCTS

### A. Service Entrance Suppressors

#### 1. Surge Protection Devices:

- a. Non-modular.
- b. LED indicator lights for power and protection status.
- c. Audible alarm, with silencing switch, to indicate when protection has failed.
- d. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

#### OR

#### Surge Protection Devices:

- e. Comply with UL 1449.
  - f. Modular design (with field-replaceable modules) **OR** Non-modular design, **as directed**.
  - g. Fuses, rated at 200-kA interrupting capacity.
  - h. Fabrication using bolted compression lugs for internal wiring.
  - i. Integral disconnect switch (if a fused switch or circuit breaker is not provided for the TVSS in the panelboard and the TVSS will not have a direct bus bar connection).
  - j. Redundant suppression circuits.
  - k. Redundant replaceable modules.
  - l. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
- OR**
- Arrangement with wire connections to phase buses, neutral bus, and ground bus.
- m. LED indicator lights for power and protection status.
  - n. Audible alarm, with silencing switch, to indicate when protection has failed.
  - o. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
  - p. Four **OR** Six, **as directed**, -digit transient-event counter set to totalize transient surges.
2. Peak Single-Impulse Surge Current Rating: 320 kA per mode/640 kA **OR** 240 kA per mode/480 kA **OR** 160 kA per mode/320 kA, **as directed**, per phase.
  3. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2
    - a. Line to Neutral: 70,000 A.
    - b. Line to Ground: 70,000 A.
    - c. Neutral to Ground: 50,000 A.
  4. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 V **OR** 208Y/120 V **OR** 600Y/347 V, **as directed**, 3-phase, 4-wire circuits shall be as follows:
    - a. Line to Neutral: 800 V for 480Y/277 V **OR** 400 V for 208Y/120 V **OR** 1200 V for 600Y/347 V, **as directed**.
    - b. Line to Ground: 800 V for 480Y/277 V **OR** 400 V for 208Y/120 V **OR** 1200 V for 600Y/347 V, **as directed**.
    - c. Neutral to Ground: 800 V for 480Y/277 V **OR** 400 V for 208Y/120 V **OR** 1200 V for 600Y/347 V, **as directed**.

#### OR

Protection modes and UL 1449 SVR for 240/120 V, single-phase, 3-wire circuits shall be as follows:



- a. Line to Neutral: 400 V.
- b. Line to Ground: 400 V.
- c. Neutral to Ground: 400 V.

**OR**

Protection modes and UL 1449 SVR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:

- a. Line to Neutral: 400 V, 800 V from high leg.
- b. Line to Ground: 400 V.
- c. Neutral to Ground: 400 V.

**OR**

Protection modes and UL 1449 SVR for 240 V, 480 V, or 600 V, 3-phase, 3-wire, delta circuits shall be as follows:

- a. Line to Line: 2000 V for 480 V **OR** 1000 V for 240 V **OR** 2500 V for 600 V, **as directed**.
- b. Line to Ground: 2000 V for 480 V **OR** 1000 V for 240 V **OR** 2500 V for 600 V, **as directed**.

**B. Panelboard Suppressors****1. Surge Protection Devices:**

- a. Non-modular.
- b. LED indicator lights for power and protection status.
- c. Audible alarm, with silencing switch, to indicate when protection has failed.
- d. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

**OR**

Surge Protection Devices:

- a. Comply with UL 1449.
  - b. Modular design (with field-replaceable modules) **OR** Non-modular design, **as directed**.
  - c. Short-circuit current rating complying with UL 1449, and matching or exceeding the panelboard short-circuit rating and redundant suppression circuits; with individually fused metal-oxide varistors.
  - d. Fuses, rated at 200-kA interrupting capacity.
  - e. Fabrication using bolted compression lugs for internal wiring.
  - f. Integral disconnect switch (if a fused switch or circuit breaker is not provided for the TVSS in the panelboard and the TVSS will not have a direct bus bar connection).
  - g. Redundant suppression circuits.
  - h. Redundant replaceable modules.
  - i. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
  - j. LED indicator lights for power and protection status.
  - k. Audible alarm, with silencing switch, to indicate when protection has failed.
  - l. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
  - m. Four **OR** Six, **as directed**, -digit transient-event counter set to totalize transient surges.
2. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA **OR** 120 kA per mode/240 kA **OR** 80 kA per mode/160 kA, **as directed**, per phase.
  3. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2:
    - a. Line to Neutral: 70,000 A.
    - b. Line to Ground: 70,000 A.
    - c. Neutral to Ground: 50,000 A.
  4. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 V **OR** 208Y/120 V **OR** 600Y/347 V, **as directed**, 3-phase, 4-wire circuits shall be as follows:
    - a. Line to Neutral: 800 V for 480Y/277 V **OR** 400 V for 208Y/120 V **OR** 1200 V for 600Y/347 V, **as directed**.



- b. Line to Ground: 800 V for 480Y/277 V **OR** 400 V for 208Y/120 V **OR** 1200 V for 600Y/347 V, **as directed**.
- c. Neutral to Ground: 800 V for 480Y/277 V **OR** 400 V for 208Y/120 V **OR** 1200 V for 600Y/347 V, **as directed**.

**OR**

Protection modes and UL 1449 SVR for 240/120-V, single-phase, 3-wire circuits shall be as follows:

- a. Line to Neutral: 400 V.
- b. Line to Ground: 400 V.
- c. Neutral to Ground: 400 V.

**OR**

Protection modes and UL 1449 SVR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:

- a. Line to Neutral: 400 V, 800 V from high leg.
- b. Line to Ground: 400 V.
- c. Neutral to Ground: 400 V.

**OR**

Protection modes and UL 1449 SVR for 240 V, 480 V, or 600 V, 3-phase, 3-wire, delta circuits shall be as follows:

- a. Line to Line: 2000 V for 480 V **OR** 1000 V for 240 V **OR** 2500 V for 600 V, **as directed**.
- b. Line to Ground: 1500 V for 480 V **OR** 800 V for 240 V **OR** 2500 V for 600 V, **as directed**.

## C. Enclosures

- 1. Indoor Enclosures: NEMA 250 Type 1 **OR** Type 12, **as directed**.
- 2. Outdoor Enclosures: NEMA 250 Type 3R **OR** Type 4 **OR** Type 4X, **as directed**.

## 1.3 EXECUTION

## A. Installation

- 1. Install TVSS devices at service entrance on load side, with ground lead bonded to service entrance ground.
- 2. Install TVSS devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
  - a. Provide multiple, 30 **OR** 60 **OR** 100, **as directed**, -A circuit breaker as a dedicated disconnecting means for TVSS unless otherwise indicated.

## 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 each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
  - b. After installing TVSS devices but before electrical circuitry has been energized, test for compliance with requirements.
  - c. Complete startup checks according to manufacturer's written instructions.
- 3. TVSS device will be considered defective if it does not pass tests and inspections.
- 4. Prepare test and inspection reports.

## C. Startup Service



- 
- a. Do not energize or connect service entrance equipment **OR** panelboards **OR** control terminals **OR** data terminals, **as directed**, to their sources until TVSS devices are installed and connected.
  - b. Do not perform insulation resistance tests of the distribution wiring equipment with the TVSS installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.
- D. Demonstration
- a. Train Owner's maintenance personnel to maintain TVSS devices.

END OF SECTION 26 43 13 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 51 13 00	02 84 16 00	Removal of Fluorescent Light Ballasts/Capacitors and Fluorescent Light Tubes
26 51 13 00	02 84 16 00a	Interior Lighting
26 51 13 00	02 84 16 00b	Exterior Lighting
26 53 00 00	02 84 16 00a	Interior Lighting



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## SECTION 26 55 61 00 - STAGE LIGHTING

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for stage 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. Dimmer racks.
  - b. Control console and control devices.
  - c. Lighting fixtures and accessories.
  - d. Distribution components.

#### C. Performance Requirements

1. Seismic Performance: Dimmer racks 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," **as directed**.

#### D. Submittals

1. Product Data: For each type of product indicated.
2. Seismic Qualification Certificates: For **<Insert equipment,>** accessories, and components, from manufacturer.
3. Field quality-control reports.
4. Operation and maintenance data.
5. Software and Firmware Operational Documentation.

#### 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 NECA 1.
3. Comply with NFPA 70.

#### F. Software Service Agreement (if allowed)

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. Plug Connectors

1. Pin Type: USITT S3, two-pole, three-wire, 20-A.
2. Twist-Locking Type: NEMA WD 6, two-pole, three-wire, 20-A.



## B. Lighting Fixtures And Accessories

1. General:
  - a. Comply with UL 1573 and listed and labeled by an NRTL.
  - b. Fixtures: Equipped with pigtail, yoke with pipe clamp, safety cable for batten mounting, and filter holder.
  - c. Metal Parts: Free of burrs, sharp corners, and edges.
  - d. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
  - e. Fixture Doors and Their Internal Access: Smooth operating, free of light leakage under operating conditions, and arranged to permit relamping without use of tools. Doors, lenses, diffusers, and other pieces arranged to prevent accidental falling during relamping and when secured in operating position.
  - f. Pigtail: Factory wired, 36-inch- (900-mm-) long, three-wire cord and plug connector assembly with cord encased in woven fiberglass or silicone tubing.
  - g. Lamp Sockets: Relampable without disturbing alignment or focus adjustment.
  - h. Fixture Ventilation Openings: Baffled against light leaks.
  - i. Fixture Operating Controls and Handles: Thermally insulated.
  - j. Lenses: Borosilicate glass in silicone mountings.
  - k. Framing Shutters: Stainless steel, four way; with each blade in a separate plane under adjustable tension mounting. Blades adjust plus or minus 30 degrees of rotation in gate, for 120-degree-minimum total angular rotation between adjacent blades.
  - l. Color Filter Frame Holder: Attached to front of fixture.
  - m. Fixture Yoke: Rigid metal, arranged for vertical aiming of unit and equipped with T-bolt or hand screw to lock alignment.
2. Ellipsoidal Spotlights: Fixtures with an elliptical reflector mounted in a fixed relationship to the lamp. Light shall be projected through a gate where the beam is shaped by using shutters, a gobo, or an iris. The shaped beam shall then be focused by a system of lenses.
  - a. Tag: ES-1:
    - 1) Lamp: 1000 W Q1000/4CL, ANSI FEL.
    - 2) Pattern Holders: Three for each fixture, with framing shutters.
    - 3) Color Frame: Black, metal.
    - 4) Minimum Cosine Illumination Performance Ratings When Operated with ANSI C78 Series, FEL Lamp:
      - a) 171,000 beam candlepower at 20-degree field angle.
      - b) 48,000 beam candlepower at 40-degree field angle.
3. Zoom Ellipsoidal Spotlights: Fixtures with an elliptical reflector mounted in an adjustable relationship to the lamp. Light shall be projected through a gate where the beam is shaped by using shutters, a gobo, or an iris. The shaped beam shall then be focused by a system of lenses.
  - a. Tag: ZES-1:
    - 1) Lamp: 1000 W Q1000/4CL, ANSI FEL.
    - 2) Pattern Holders: Three for each fixture, with framing shutters.
    - 3) Operator adjustable from 25- to 50-degree field angle.
    - 4) Field-angle adjustment scale label on instrument housing for field reference.
    - 5) Minimum Cosine Illumination Performance Rating When Operated with ANSI C78 Series, FEL Lamp: 82,000 beam candlepower at 35-degree field angle.
4. Fresnel Lens Spotlights:
  - a. Die-cast extruded-aluminum housing, with hinged front for relamping.
  - b. Tag: FLS-1.
    - 1) Lamp: 1000 W Q1000T7/4CL, ANSI EGT.
    - 2) Lens: 6 inches (152 mm).
    - 3) Illumination Performance Rating When Operated with ANSI C78 Series, EGT Lamp:
      - a) 175,000 beam candlepower at 12.5-degree field angle in spot focus.
      - b) 12,000 beam candlepower at 74.6-degree field angle in flood focus.
    - 4) Barn Doors: Two 4-leaf rotatable metal flaps for every three fixtures.
5. Follow Spotlights:



- a. Tag: FS-1:
  - 1) Lamp: Metal halide, G22 medium bi-post, CRI: 90, color: 6000 K, life: 750 hours, HMI 575 W/GS 95 V.
  - 2) Adjustable lenses in metal housing.
  - 3) Lamp: Quartz-projector type, Adjustable, underslung base stand mounted on 3-inch (75-mm), locking-type, rubber-tired, ball-bearing casters.
  - 4) Adjustable lamp holder and socket assembly with precision tuning adjustment; relampable without tools.
  - 5) Three-leaf, full-range mechanical dimmer.
  - 6) Adjustable iris and framing shutters.
  - 7) Automatic color boom.
  - 8) Removable power cable, 25 feet (8 m) long.
  - 9) Iris Open, Spot-Focus Performance: 800,000, **as directed**, beam candlepower at 7.2, **as directed**, -degree field angle.
  - 10) Iris Open, Flood-Focus Performance: 330,000, **as directed**, beam candlepower at 12.2, **as directed**, -degree field angle.
6. PAR Lamp Holders:
  - a. Tag: PLH-1:
    - 1) Lamp: 300 W PAR 38.
    - 2) Housing: Steel or aluminum, flat black color, **as directed**, with porcelain-plated shell socket.
    - 3) Barn Doors: Two 4-leaf rotatable metal flaps for every three fixtures.
  - b. Tag: **<Insert drawing designation>**.
    - 1) Lamp: 575 W tungsten halogen, 90 GLA 575 W, 230 V, color: 3200 K, ANSI GKV.
    - 2) Housing: Steel or aluminum, with porcelain-plated shell socket and color frame, **as directed**.
    - 3) Barn Doors: Two 4-leaf rotatable metal flaps for every three fixtures.
    - 4) With Lens Holder and Replaceable Lenses:
      - a) **<Insert drawing designation>**: Very narrow spot.
      - b) **<Insert drawing designation>**: Narrow spot.
      - c) **<Insert drawing designation>**: Medium flood.
      - d) **<Insert drawing designation>**: Wide flood.
      - e) **<Insert drawing designation>**: Very wide.
    - 5) Motorized **OR** Manual, **as directed**, color wheel.
7. Borderlight Units: Compartmented, three-circuit striplight with nine 150-W, PAR 38/SP **OR** 150-W, PAR 38/FL **OR** 250-W, PAR 38/SP **OR** 150-W, R40/FL, **as directed**, lamps in porcelain sockets and steel sheet housing, 90 inches (2286 mm) long. Compartments shall be in line and wired on two **OR** three **OR** four, **as directed**, alternate circuits, each producing a different color.
  - a. Front Door: Spring loaded; designed to hold either filter frames or color roundels.
  - b. Color Roundels: One for each lamp; alternating red, blue, and clear, **as directed**.
    - 1) Additional Roundels: **<Insert number>** amber and **<Insert number>** green.
  - c. Hanger: Adjustable, steel-strap type equipped at each end with pipe clamp and safety cable for suspension from a batten.
8. Cyclorama Lights: Suitable for lighting cycloramas from above.
  - a. Tag: CL-1:
    - 1) Lamp: 1000 W Q1000T3/1CL, ANSI FFT.
    - 2) Housing: Aluminum or steel, **as directed**, flat black color, **as directed**, with color frame, **as directed**.
9. Black Lights: Portable, producing a wash of UV light for special effects.
  - a. Tag: BL-1:
    - 1) Lamp: 250 W blacklight flood, H37KB-250, with integral filter to eliminate far-UV effect while maximizing the near-UV effect.
    - 2) Housing: Steel or aluminum, **as directed**, flat black color, **as directed**, with carry handle.
    - 3) C-clamp for using on light pipe.
10. Moving Lights:



- a. Tag: ML-1:
  - 1) General: 700-W, 120-V, metal halide, motorized remote-controlled lighting instrument; NRTL listed.
  - 2) Lamp: Short-arc metal halide, 14,500 lumens; color temperature of 5600 K, CRI of 80.
  - 3) Color System: Three-filter CYM (cyan, yellow, magenta) cross-fading mechanism, and 11 standard colors on a fixed wheel.
  - 4) Optics: Zoom optics with continuously variable field angle from 18.5 to 42 degrees, programmable over a timed range of 2 seconds to 20 minutes; with a mechanical iris for beam-size control. Variable beam focus to soften the edges of gobos and light beams. Zoom combined with iris can project a beam with a field angle of 8 degrees.
  - 5) Dimming: Coated glass dimmer wheel, with controls to provide smooth timed fades.
  - 6) Strobe for strobe lighting effects.
  - 7) Gobo: One rotating wheel with five rotatable wheel positions and one open position. One fixed gobo wheel with 11 pattern positions and one open position.
  - 8) Beam Orientation Control: Smooth pan and tilt using a three-phase stepper motor system. Pan, 540 degrees; tilt, 270 degrees at 0.3-degree repeatability on either axis.
  - 9) Control: ANSI E1.11 (USITT DMX512-A) protocol using five pin connectors.

### C. Distribution Components

1. Connector Strip: Listed and labeled by an NRTL; factory-wired wireway and receptacle assembly.
  - a. Wireway: Steel or extruded aluminum, with removable cover and nominal cross-section dimensions of 3 by 4-1/2 inches (75 by 115 mm).
  - b. Accessories: Cable clamps, support cradles, and cable strain relief grips for each cable.
  - c. Receptacles: Pigtail mounted, 18 inches (450 mm) long, with strain relief at wireway wall penetration.  
**OR**  
Receptacles: Flush mounted in wireway cover.
  - d. Receptacle Wiring: For connecting to terminal blocks; with 125 deg C, crosslinked, PE-insulated, identification-labeled wire.
  - e. Terminal Blocks: Molded-barrier type with screw lugs to suit supply conductors.
  - f. Mounting Hardware: Furnished with each unit; permits surface, single-pipe-bracket, or double-pipe-bracket mounting.
  - g. Finish: Semigloss or matte black.
2. Plug-in Boxes: Listed and labeled by an NRTL; factory-wired wireway and receptacle assembly, 24 inches (600 mm) long unless otherwise indicated; with the following features:
  - a. Wireway: Steel or extruded aluminum, with removable cover and nominal cross-section dimensions of 3 by 4-1/2 inches (75 by 115 mm).
  - b. Accessories: Cable clamps, support cradles, and cable strain relief grips for each cable.
  - c. Receptacles: Pigtail mounted, 18 inches (450 mm) long, with strain relief at wireway wall penetration.  
**OR**  
Receptacles: Flush mounted in wireway cover.
  - d. Receptacle Wiring: For connecting to terminal blocks; with 125 deg C, crosslinked, PE-insulated, identification-labeled wire.
  - e. Terminal Blocks: Molded-barrier type with screw lugs to suit supply conductors.
  - f. Surface or Grid Mounting: With accessories for surface mounting or with pipe-mounting accessory bracket.
  - g. Recessed Mounting: With flanged cover suitable for recessed mounting in wall.
  - h. Finish: Semigloss or matte black.
3. Gridiron Junction Boxes: Listed and labeled by an NRTL; factory wired with terminal strips and concentric knockouts on all sides.
  - a. Terminal Blocks: Molded-barrier type with screw lugs to suit supply conductors.



- b. Accessories: Cable clamps, support cradles, and cable strain relief grips for each cable, and brackets for surface or pipe mounting.
  - c. Finish: Semigloss or matte black.
  - 4. Floor Pockets: Listed and labeled by an NRTL; flush-mounted, receptacle outlet assembly.
    - a. Box: 0.0598-inch (1.5-mm) steel sheet, 10 inches (250 mm) deep.
    - b. Cover Plate: Steel, cast iron, or cast aluminum with nonskid safety tread surface and self-closing, hinged door with cable notches.
    - c. Barrier for allowing installation of low-voltage control receptacle for console input or handheld remotes.
- D. Wire And Cable
- 1. Building Wire in Raceways: Comply with requirements specified in Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
  - 2. Portable Power Cable: Listed and labeled by an NRTL; flexible stage and lighting power cable; Type SC, SCE, or SCT; 600 V; multiconductor; 60 deg C temperature rating.
  - 3. Ethernet Cabling: Comply with requirements specified in Division 26 Section "Control-voltage Electrical Power Cables".
    - a. For 10/100BaseT, comply with provisions for UTP cable and hardware.
    - b. For 10Base-FL, comply with provisions for 50/125 **OR** 62.5/125, **as directed**,-micrometer, multimode, optical-fiber cable and hardware.
  - 4. ANSI E1.11 (USITT DMX512-A) Control Cabling: Comply with requirements specified in Division 26 Section "Control-voltage Electrical Power Cables".
    - a. Standard Cable: NFPA 70, Type CM **OR** Type CMG, **as directed**.
      - 1) Paired, low-capacitance computer cable for ANSI E1.11 (USITT DMX512-A) applications. Two pairs, twisted, No. 22 AWG **OR** No. 24 AWG, **as directed**, stranded, tinned-copper conductors.
      - 2) PE insulation.
      - 3) Inner Shield: 100 percent coverage, aluminum foil-polyester tape.
      - 4) Outer Shield: 90 percent coverage, tinned-copper braid.
      - 5) Outer Shield Drain Wire: Stranded, tinned copper.
      - 6) PVC jacket.
      - 7) Flame Resistance: Comply with UL 1581.
    - b. Plenum-Rated Cable: NFPA 70, Type CMP.
      - 1) Paired, low-capacitance computer cable for ANSI E1.11 (USITT DMX512-A) applications. Two pairs, twisted, No. 22 AWG **OR** No. 24 AWG, **as directed**, stranded, tinned-copper conductors.
      - 2) Insulation: Foam fluoridated ethylene propylene.
      - 3) Inner Shield: 100 percent coverage, aluminum foil-polyester tape.
      - 4) Outer Shield: 90 percent coverage, tinned-copper braid.
      - 5) Outer Shield Drain Wire: Stranded, tinned copper.
      - 6) Low-smoke PVC jacket.
      - 7) Flame Resistance: Comply with NFPA 262.
  - 5. Low-Voltage Control Cabling:
    - a. Control-Cable Conductors:
      - 1) Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway; complying with UL 83.  
**OR**  
Class 1 Control Circuits: Stranded copper, Type THHN, in raceway; complying with UL 44.
      - 2) Class 2 Control Circuits: Stranded copper, Type THHN-THWN, 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**  
Class 2 Control Circuits: Stranded copper, Type THHN, in raceway **OR** power-limited cable, concealed in building finishes **OR** power-limited tray cable, in cable tray, **as directed**; complying with UL 44.



- 3) Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF; complying with UL 83.
- b. Paired Cable: NFPA 70, Type CMG.
  - 1) One pair, twisted, No. 16 AWG, stranded, tinned-copper conductors.
  - 2) PVC insulation.
  - 3) Unshielded.
  - 4) PVC jacket.
  - 5) Flame Resistance: Comply with UL 1581.
- c. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
  - 1) One pair, twisted, No. 16 AWG, stranded (19x29), tinned-copper conductors.
  - 2) PVC insulation.
  - 3) Unshielded.
  - 4) PVC jacket.
  - 5) Flame Resistance: Comply with NFPA 262.
- d. Paired Cable: NFPA 70, Type CMG.
  - 1) One pair, twisted, No. 18 AWG, stranded (19x30), tinned-copper conductors.
  - 2) PVC insulation.
  - 3) Unshielded.
  - 4) PVC jacket.
  - 5) Flame Resistance: Comply with UL 1581.
- e. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
  - 1) One pair, twisted, No. 18 AWG, stranded (19x30), tinned-copper conductors.
  - 2) Fluorinated ethylene propylene insulation.
  - 3) Unshielded.
  - 4) Plastic jacket.
  - 5) Flame Resistance: Comply with NFPA 262.

#### E. Lighting Control System

1. Description: Microprocessor-based modular system consisting of dimmer and control modules operated from remote-control stations and a control console.
  - a. Comply with UL 508.
  - b. Comply with USITT AMX192 **OR** ANSI E1.11 (USITT DMX512-A), **as directed**, for data transmission.
2. Dimmer Racks: Listed and labeled by an NRTL; dead-front, front-access, wall-mounted **OR** freestanding, **as directed**, rack for mounting modular dimmers; formed-steel or extruded-aluminum structural members; completely enclosed with steel or aluminum panels. Painted with manufacturer's standard corrosion-resistant primer and finish coats, and having the following features:
  - a. Primary Circuit Breaker: Fault-current withstand rating of the rack; not less than 10,000 **OR** 50,000, **as directed**, A, symmetrical.
  - b. Hinged, locking front door, with openings to allow air intake across the face of all dimmer modules.
  - c. Individual rack sections shall not exceed 84 inches high by 25 inches deep by 30 inches wide (2134 mm high by 635 mm deep by 762 mm wide). Multisection racks shall be interconnected with busbars.
  - d. For each module position, provide support rails and control-pin configurations, constructed for precise alignment of dimmer modules into power and signal connector sockets.
  - e. Forced-air cooling of each rack for maintaining operating temperature at each dimmer, assuming full load, in ambient temperature not to exceed 40 deg C. Exhaust rates shall be variable, using temperature sensors and fan-speed control electronics. Individual control of multiple fans is acceptable in lieu of fan-speed control. Fan(s) shall start and stop automatically. Fan noise at full load shall be less than 3.1 sones.
  - f. Each rack shall have an automatic air-temperature sensor to shut off all dimmers in the rack should the internal temperature rise above maximum safe operating limits. In an



- overheat condition, the fan shall continue operating. When a safe operating temperature is restored, the system shall automatically reset to allow normal user control.
- g. Fabricate and test dimmer racks to withstand seismic forces defined in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".
3. Dimmers: Modular solid-state units that operate smoothly over their operating ranges without audible lamp noise or radio-frequency interference at any setting. Modules shall be dead-front, draw-out type with floating line, load, and control sockets for smooth insertion and withdrawal; with load-side thermal-magnetic circuit breaker, speed-controlled cooling fan, and overtemperature sensor.
    - a. Non-Dim Units: On-off relay control only. Capable of serving inductive loads such as motors or high-intensity-discharge fixtures.
    - b. Surge Protection: Modules shall withstand power-line surges of 6000 V/3000 A according to IEEE C62.41.1 and IEEE C62.41.2.
    - c. Filter each dimmed circuit to provide a minimum 350-mic.sec., current-rise time at a 90-degree conduction angle at 50 percent of rated dimmer capacity. At any load within rating, rate of current rise shall not exceed 30 mA/mic.sec., measured from 10 to 90 percent of load current waveform.
  4. Control System: Microprocessor-based control system, ANSI E1.11 (USITT DMX512-A) protocol, with a nonvolatile system memory to adjust dimmer channel settings for different scenes, to patch dimmers to channels, and to manually or automatically change dimmer settings from one preset scene to another.
    - a. Control shall support Ethernet-based LAN at every control device.
    - b. Provide means to create and monitor show data on a PC using software by console manufacturer. Software shall be capable of the following:
      - 1) Creating show and providing for use of USITT show files.
      - 2) Playing back show in a console-simulation mode.
      - 3) Accessing all remote-control stations associated with the console and control system.
      - 4) Providing standard Ethernet connection between the console control system and the PC.
    - c. Display the following system status information on a color, 17-inch (430-mm) LCD monitor associated with the control console:
      - 1) Current channel intensities.
      - 2) Cue information.
      - 3) Monitor.
    - d. Moving Lights: Include a standard control library, a program patch specific to fixture(s) provided, and selective programming with ANSI E1-11 (USITT DMX512-A) addressing of fade, focus points, beam, image, color, <Insert attributes> and position.
  5. Control Console: Tabletop unit with manual and computer-based programming controls, memory units, indicating devices, and the following features:
    - a. Servicing access through hinged top panel.
    - b. Grand-master level control.
    - c. Blackout switch.
    - d. 12 submaster level controls with overlapping pile-on performance.  
**OR**  
24 submaster level controls with overlapping pile-on performance.
    - e. Bump buttons for momentary control of channels or submasters, one for each submaster level control.
    - f. Two cross-fade controls for split dipless fade between scenes, each with its own fade progress indicator.
    - g. One set of scene level controls for each scene when used in two-scene preset mode. Second set of scene level controls to allow setting levels into memory for expanded single scenes when used in multiple single-channel scene mode. Each set shall have same quantity of scene level controls as is used for submaster level controls.
    - h. Multibutton keypad for programming in multiscene memory mode.



- i. Fade time control for assigning fade time to cues, with individual cue adjustment from one second to five minutes, minimum.
  - j. Light-emitting diode **OR** LCD **OR** Computer monitor cathode-ray tube, **as directed**, with associated display controls, for displaying operating menus and memory readout.
  - k. Controls for setting levels into memory.
  - l. Cord and connector for connecting console to outlets for console power and control.
6. System Operation: Selectable between multichannel two-scene preset and four-channel single-scene memory. Console features include electronic patching of control signals for up to 512 dimmers and off-line data storage using internal, 3-1/2-inch (90-mm) disk-drive unit. Operational capability includes the following:
- a. Live and blind programming.
  - b. Special effects programmability for automatic operation of lights in pulsating, sequential dimming and brightening, and other special operating modes. Special effects menu displays operator guidance for programming and individual step levels.
  - c. Signal from fire-alarm control panel that automatically brings selected circuits to fully on or fully bright condition, overriding normal dimming and on-off controls.
  - d. Inserting cues between designated cues without renumbering.
  - e. Out-of-sequence playback of cues.
  - f. Controlling houselights and stage lights from console by assigning their dimmers or non-dim on-off controls to a channel.
  - g. Retaining programmed cues in memory for minimum of one year after power outage.
  - h. Automatic sequential execution of programmed cues.
  - i. Printing cues using parallel or serial printer port, cable, and printer. Cable and printer are not included with this system.
7. PC: Standard, unmodified, with accessories and peripherals that are configured to install and run control-console manufacturer's written requirements, but not less than the following:
- a. CPU operating speed shall be at least 1.6 GHz.
  - b. Memory: 1024 MB.
  - c. Serial Ports: Provide two for general use.
  - d. Parallel Port: Enhanced.
  - e. LAN Adapter: 10/100/1000 Mbps, internal network interface card.
  - f. Three USB 2.0 ports.
  - g. Sound Card: For playback and recording of digital WAV sound files that are associated with audible warning and alarm functions.
  - h. Color Monitor: Not less than 17 inches (430 mm), with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 mm. Video card shall support at least 256 colors at a resolution of 1280 by 1024 pixels at a minimum refresh rate of 70 Hz.
  - i. Keyboard: With a minimum of 64 characters; standard ASCII character set based on ANSI INCITS 154 (formerly ANSI X3.154).
  - j. Mouse: Standard, compatible with installed software.
  - k. Disk storage shall include the following, each with appropriate controller:
    - 1) Minimum 60 GB hard disk, 5400 rpm.
    - 2) Floppy Disk Drive: High density, 3-1/2-inch (90-mm) size.
    - 3) **<Insert disk drives>**.
  - l. CD-ROM Drive: 24x/10x/24x CD-RW/8x DVD combination.
8. Console Power and Control Outlets: Multiple receptacles matched to connector on console connector cord.
9. House Lighting Control Station: Architectural-type, multichannel, remote-dimmer-control station with the following features:
- a. System controls designated houselights, stage lights, and other lights.
  - b. Stage lighting controls compatible with dimming and control system.
  - c. Flush mounting.
  - d. Brushed-aluminum wall plate.
  - e. Five **OR** Six, **as directed**, channels, each with slider potentiometer control.



- f. Master-slider potentiometer that controls lights on all channels proportionally from completely dimmed to degree of brightness that corresponds to individual slider positions.
  - g. Fully on switch that turns all channels on at full brightness regardless of slider position.
  - h. Take-control/off switch that places station in control of channels and sets lighting to levels dictated by channel and master-slider controls.
  - i. Legend on face of wall plate that identifies items as "House Lighting Control Station" and identifies functions of each slider and switch position, with slider positions individually graduated from zero to 10.
  - j. Illuminated push buttons for activating preset scenes of house lighting and labeled "Entry" **OR** "Panic" **OR** "Entry" and "Panic," **as directed**.
  - k. Flush wall mounted unless otherwise indicated.
10. Entry Station: Push button activates or deactivates indicating light and presets scene of house lighting control system.
    - a. Light-emitting-diode indicating light illuminates when preset command is executed.
    - b. Labeled "Entry."
    - c. Flush wall mounted unless otherwise indicated.
  11. Key-Entry Station: Key-operated switch controls station to activate or deactivate indicating light and presets scene of lighting control system.
    - a. Light-emitting-diode indicating light illuminates when preset command is executed.
    - b. Labeled "Entry."
    - c. Flush wall mounted unless otherwise indicated.
  12. Emergency Lighting Control Station: Key-operated, **as directed**, push button activates indicating light and brings selected dimmers to fully bright condition, i.e., the "Panic" preset. Operating push button a second time returns dimmers to previous setting.
    - a. Emergency mode indicating light.
    - b. Labeled "Emergency Lights."
    - c. Flush wall mounted unless otherwise indicated.

#### F. Rigging Components

1. Pipe Clamps: Malleable iron, suitable for clamping fixtures or items to pipe from 3/4 to 2 inches (20 to 51 mm) in OD. Arranged for horizontal rotation of yoke for aiming; equipped with T-bolt to lock alignment.
2. Safety Cables: Heavy-duty, flexible steel; 30-inch (762-mm) nominal length, with spring clip at one end and steel ring at the other end.
3. Cable Grips: Stainless **OR** Galvanized, **as directed**, steel; basket-weave type for supporting stage cables.

### 1.3 EXECUTION

#### A. Installation

1. Set permanently mounted items level, plumb, and square with ceilings and walls.
2. Indicated mounting heights are to bottom of unit for suspended items and to center of unit for wall-mounted items.
3. Mount and connect fixtures, and install and connect distribution devices.
  - a. If arrangement is not indicated, install so each fixture, dimmer, house lighting circuit, control channel, and outlet circuit can be operated, and complete system demonstrated, in all operating modes.
  - b. Install safety cables secured to stage rigging or gridiron for all pipe-mounted electrical fixtures and equipment.
4. Dimmer Rack Mounting: Install and anchor dimmer racks level on 4-inch- (100-mm-) high concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
  - a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.



- b. For dimmer racks, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - d. Install anchor bolts to elevations required for proper attachment to dimmer racks.
5. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration And Seismic Controls For Electrical Systems".

#### B. Wiring

1. Power Wiring:
  - a. Install wiring as specified in Division 26 Section "Low-voltage Electrical Power Conductors And Cables" for hardwired connections. Install wiring in raceways except cable and plug connections.
  - b. Install power wiring with a separate neutral for each output circuit from main dimmer and for each house and stage lighting circuit.
2. Signaling, Remote-Control, and Power-Limited Circuits:
  - a. Comply with requirements specified in Division 26 Section "Control-voltage Electrical Power Cables" for installation of wiring. Install wiring in raceways except cable and plug connections.
  - b. Comply with the following unless otherwise indicated:
    - 1) Size conductors according to lighting control device manufacturer's written instructions.
    - 2) Select cable insulation, shielding, drain wire, and jacket complying with lighting control device manufacturer's written instructions.
    - 3) Install circuits to eliminate radio-frequency interference and electromagnetic interference.
  - c. Remote-control circuits associated with emergency lighting control shall be installed complying with Class 1 Circuit standards in NFPA 70.
3. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points.
4. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes and in terminal cabinets and equipment enclosures.
5. Remove wall plates and protect devices and assemblies during painting.
6. Support lighting fixtures, distribution components, and accessories as specified in Division 26 Section "Hangers And Supports For Electrical Systems". Equip all pipe-mounted equipment with safety cables that are secured to supporting pipe.
7. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".

#### C. Identification

1. Identify components, power, and control wiring according to Division 26 Section "Identification For Electrical Systems".
2. Label each fixture, lighting outlet, distribution device, and dimmer module with unique designation. Labels on elevated components shall be readable from the floor.

#### D. Field Quality Control

1. Perform tests and inspections.
2. Tests and Inspections:
  - a. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.
  - b. Visual and Mechanical Tests and Inspections:
    - 1) Inspect each fixture, outlet, module, control, and device for defects, finish failure, corrosion, physical damage, labeling by an NRTL, and nameplate.
    - 2) Exercise and perform operational tests on mechanical parts and operable devices according to manufacturer's written instructions.
    - 3) Check tightness of electrical connections with torque wrench.



- 4) Verify proper protective device settings, fuse types, and ratings.
  - 5) Record results of tests and inspections.
  - c. Electrical Tests: Perform tests according to manufacturer's written instructions.
    - 1) Continuity tests of circuits.
    - 2) Operational Tests: Connect each outlet to a fixture and a dimmer output circuit so each dimmer module, dimmer control and output circuit, outlet, and fixture in a typical operating mode will be sequentially tested. Set and operate controls to demonstrate fixtures, outlets, dimmers, and controls in a sequence that cues and reproduces actual operating functions for a typical system of the size and scope installed. Include operation and control of houselights and stage lights from each control location and station including optional plug-in, control-console outlet locations. Record fixture and outlet assignments, control settings, operations, cues, and observations of performance.
  - d. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible organization and individual.
  3. Stage lighting will be considered defective if it does not pass tests and inspections.
  4. Prepare test and inspection reports.
    - a. Prepare a schedule of lighting outlets by number; indicate circuits, dimmers, connected fixtures, and control-channel assignments. Prepare a schedule of control settings and circuit assignments for house control channels. Prepare written reports of tests and observations. Report defective materials, workmanship, and unsatisfactory test results. Include records of repairs and adjustments made.
- 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.

END OF SECTION 26 55 61 00



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## SECTION 26 55 68 00 - SPORTS LIGHTING

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for exterior athletic 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 lighting for the following outdoor sports venues:
  - a. Baseball fields.
  - b. Softball fields.
  - c. Football fields.
  - d. Soccer fields.
  - e. Outdoor tennis courts.

#### C. Definitions

1. CV: Coefficient of variation; a statistical measure of the weighted average of all relevant illumination values for the playing area, expressed as the ratio of the standard deviation for all illuminance values to the mean illuminance value.
2. Delegated-Design Submittals: Documents, including drawings, calculations, and material and product specifications prepared as a responsibility of Contractor to obtain acceptance by the Owner and authorities having jurisdiction.
3. Illuminance: The metric most commonly used to evaluate lighting systems. It is the density of luminous flux, or flow of light, reaching a surface divided by the area of that surface.
  - a. Horizontal Illuminance: Measurement in foot-candles (lux), on a horizontal surface 36 inches (914 mm) above ground unless otherwise indicated.
  - b. Target Illuminance: Average maintained illuminance level, calculated by multiplying initial illuminance by LLF.
  - c. Vertical Illuminance: Measurement in foot-candles (lux), in two **OR** four, **as directed**, directions on a vertical surface, at an elevation coinciding with plane height of horizontal measurements.
4. LC: Lighting Certified.
5. Light Trespass: Light spill into areas and properties outside the playing areas, which is either annoying or unwanted.
6. LLD: Lamp lumen depreciation, which is the decrease in lamp output as the lamp ages.
7. LLF: Light loss factor, which is the product of all factors that contribute to light loss in the system.
8. Luminaire: Complete lighting fixture, including ballast housing if integral.
9. UG: Uniformity gradient; the rate of change of illuminance on the playing field, expressed as a ratio between the illuminances of adjacent measuring points on a uniform grid.

#### D. Performance Requirements

1. Facility Type: Professional **OR** College **OR** Semiprofessional **OR** Sports club **OR** Amateur league **OR** High school **OR** Training facility **OR** Elementary school **OR** Recreational or social facility, **as directed**.
2. Illumination Criteria:
  - a. Minimum average target illuminance level for each lighted area for each sports venue and for the indicated class of play according to IESNA RP-6.
  - b. CV and maximum-to-minimum uniformity ratios for each lighted area equal to or less than those listed in IESNA RP-6 for the indicated class of play.
  - c. UG levels within each lighted area equal to or less than those listed in IESNA RP-6 for the indicated speed of sport.



3. Illumination Criteria:
  - a. Minimum Average Target Illumination: **<Insert value>**.
  - b. CV: **<Insert value>**.
  - c. Maximum-to-Minimum Uniformity Ratio: **<Insert value>**.
  - d. UG Level: **<Insert value>**.
4. Illumination Calculations: Computer-analyzed point method complying with IESNA RP-6 to optimize selection, location, and aiming of luminaires.
  - a. Grid Pattern Dimensions: For playing areas of each sport and areas of concern for spill-light control, correlate and reference calculated parameters to the grid areas. Each grid point represents the center of the grid area defined by the length and width of the grid spacing.
  - b. Spill-Light Control: Minimize spill light for each playing area on adjacent and nearby areas.
    - 1) Prevent light trespass on properties near Project as defined by **<Insert name(s) of authorities having jurisdiction>**.
    - 2) For areas indicated on Drawings as "spill-light critical," limit the level of illuminance directed into the area from any luminaire or group of luminaires, and measured 36 inches (914 mm) above grade to the following:
      - a) Maximum Horizontal Illuminance: 0.25 fc (2.7 lux) **OR** 0.5 fc (5.4 lux) **OR** 0.75 fc (8.1 lux), **as directed**.
      - b) Maximum Vertical Illuminance from the Direction of the Greatest Contribution of Light: 1.0 fc (10.8 lux) **OR** 2.0 fc (21.5 lux) **OR** 3.0 fc (32.3 lux), **as directed**.
    - 3) Calculate the horizontal and vertical illuminance due to spill light for points spaced 20 feet (6 m) apart in areas indicated on Drawings as "spill-light critical," to ensure that design meets the above limits.
  - c. Glare Control: Design illumination for each playing area to minimize direct glare in adjacent and nearby areas.
    - 1) Design source intensity of luminaires that may be observed at an elevation of 60 inches (1524 mm) above finished grade from nearby properties to be less than 12,000 **OR** 20,000 **OR** 30,000, **as directed**, candela when so observed.
    - 2) Design source intensity of luminaires that may be observed at an elevation of 60 inches (1524 mm) above finished grade from designated "spill-light critical" areas to be less than 12,000 **OR** 20,000 **OR** 30,000, **as directed**, candela when so observed.
  - d. Determine LLF according to IESNA RP-6 and manufacturer's test data.
    - 1) Use LLD at 100 percent of rated lamp life. LLF shall be applied to initial illumination to ensure that target illumination is achieved at 100 percent of lamp life and shall include consideration of field factor.
    - 2) LLF shall not be higher than 70 percent, and may be lower when determined by manufacturer after application of the ballast output and optical system output according to IESNA RP-6.
  - e. Luminaire Mounting Height: Comply with IESNA RP-6, with consideration for requirements to minimize spill light and glare.
  - f. Luminaire Placement: Luminaire clusters shall be outside the glare zones defined by IESNA RP-6.
5. Baseball Fields:
  - a. IESNA RP-6, Class of Play: **I OR II OR III OR IV, as directed**.
  - b. Speed of Sport: **Fast OR Moderate OR Slow, as directed**.
  - c. Grid Pattern Dimensions: 30 by 30 feet (9 by 9 m).
6. Softball Fields:
  - a. IESNA RP-6, Class of Play: **I OR II OR III OR IV, as directed**.
  - b. Speed of Sport: **Fast OR Moderate OR Slow, as directed**.
  - c. Grid Pattern Dimensions: 20 by 20 feet (6 by 6 m).
7. Football Fields:
  - a. IESNA RP-6, Class of Play: **I OR II OR III OR IV, as directed**.



- b. Speed of Sport: Fast **OR** Moderate **OR** Slow, **as directed**.
- c. Grid Pattern Dimensions: 30 by 30 feet (9 by 9 m).
8. Soccer Fields:
  - a. IESNA RP-6, Class of Play: I **OR** II **OR** III **OR** IV, **as directed**.
  - b. Speed of Sport: Fast **OR** Moderate **OR** Slow, **as directed**.
  - c. Grid Pattern Dimensions: 30 by 30 feet (9 by 9 m).
9. Outdoor Tennis Courts:
  - a. IESNA RP-6, Class of Play: I **OR** II **OR** III **OR** IV, **as directed**.
  - b. Speed of Sport: Fast **OR** Moderate **OR** Slow, **as directed**.
  - c. Grid Pattern Dimensions: 10 by 10 feet (3 by 3 m).
10. Egress Lighting: In case of power failure, provide a minimum of 1.0-fc (10.8-lux) illumination, within 30 seconds, measured at grade in spectator and spectator egress areas.
  - a. Duration of emergency illumination shall be not less than 15 minutes.
  - b. Momentary Power Interruptions: Provide emergency illumination immediately following restoration of power to the lighting circuits. Emergency illumination shall automatically extinguish after 15 minutes.
11. Lighting Control: Manual, low voltage, or digital; providing the following functions, integrated into a single control station, with multiple subcontrol stations as indicated:
  - a. Control Station: Key-operated master switch, manual push-button controls, and system status indicator lights. Test switch of egress lighting system, **as directed**.
  - b. Light Levels: Two levels of control - 100/50 percent of minimum target illumination.
12. Electric Power Distribution Requirements:
  - a. Electric Power: 208 **OR** 230 **OR** 480, **as directed**, V; three phase.
    - 1) Include roughing-in of service indicated for nonsports improvements on Project site.
    - 2) Balance load between phases. Install wiring to balance three phases at each support structure.
    - 3) Include required overcurrent protective devices and individual lighting control for each sports field or venue.
    - 4) Include indicated feeder capacity and panelboard provisions for future lighted sports field construction.
13. Maximum Total Load: **<Insert number> A**.
  - a. Maximum Total Voltage Drop from Source to Load: 5 percent, including voltage drops in branch circuit, subfeeder, and feeder.
14. Seismic Performance: Luminaires, ballasts, and support structures 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."
15. Life-Cycle Cost Criteria:
  - a. Estimated life-cycle cost of lighting system for period of **<Insert number>** years based on the parameters below:
    - 1) Energy Cost: **<Insert value>** {Calculate energy costs by multiplying (number of luminaires) x (kilowatt demand per luminaire) x (power cost at \$/kilowatts) x (number of annual usage hours) x (number of years)}.
    - 2) Lamp Replacement Cost: **<Insert value>** (Calculate replacement costs by multiplying (cost to replace a lamp) x (number of luminaires) x (number of relamps over the period of years used in calculating the energy cost)).
    - 3) General Maintenance: **<Insert value>** (Calculate maintenance costs by multiplying (number of repairs) x (cost per repair) over the life cycle).

**OR**

Life-Cycle Cost Criteria: **<Insert value>** (Calculate according to Federal Energy Management Program's "Building Life-Cycle Cost").

E. Submittals

1. Product Data: For each type of lighting product indicated. Include the following:



- a. Lamp life, output, and energy-efficiency data. Lamp data certified by NVLAP or NRTL; comply with IESNA LM-47.
  - b. Photometric data based on laboratory tests of each luminaire type, complete with lamps, ballasts, and accessories; comply with IESNA LM-5.
    - 1) Photometric data shall be certified by a qualified independent testing agency.

**OR**

Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
  2. Delegated-Design Submittal: For exterior athletic lighting 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 and specifications for construction of lighting system.
    - b. Manufacturer's determination of LLF used in design calculations.
    - c. Lighting system design calculations for the following:
      - 1) Target illuminance.
      - 2) Point calculations of horizontal and vertical illuminance, CV, and UG at minimum grid size and area.
      - 3) Point calculations of horizontal and vertical illuminance in indicated areas of concern for spill light.
      - 4) Calculations of source intensity of luminaires observed at eye level from indicated properties near the playing fields.
    - d. Electrical system design calculations for the following:
      - 1) Short-circuit current calculations for rating of panelboards.
      - 2) Total connected and estimated peak-demand electrical load, in kilowatts, of lighting system.
      - 3) Capacity of feeder **OR** service, **as directed**, required to supply lighting system.
    - e. Wiring requirements, including required conductors and cables and wiring methods.
    - f. Structural analysis data and calculations used for pole selection.
      - 1) Manufacturer Wind-Load Strength Certification: Submit certification that selected total support system, including poles, complies with AASHTO LTS-4-M for location of Project.
  3. Qualification Data: For qualified Installer, manufacturer, professional engineer, luminaire photometric data testing laboratory and field testing agency.
  4. Seismic Qualification Certificates: For luminaires, 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. Manufacturer Certificates: For support structures, including brackets, arms, appurtenances, bases, anchorages, and foundations, from manufacturer.
  6. Welding certificates.
  7. Field quality-control reports.
  8. Operation and Maintenance Data: For sports lighting system components to include in emergency, operation, and maintenance manuals.
  9. Warranty: Sample of special warranty.
- F. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
  2. Manufacturer Qualifications: Manufacturer's responsibilities include fabricating sports lighting and providing professional engineering services needed to assume engineering responsibility.



- a. Engineering Responsibility: Preparation of delegated-design submittals and comprehensive engineering analysis by a qualified professional engineer who is additionally LC by the National Council on Qualifications for the Lighting Professions, **as directed**.
3. Luminaire Photometric Data Testing Laboratory: By manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
4. Luminaire Photometric Data Testing Laboratory: By an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL.
5. Field Testing Agency Qualifications: An independent testing agency that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, or an NRTL as defined in 29 CFR 1910, with the experience and capability to conduct field testing according to IESNA LM-5.

**OR**

Field Testing Agency Qualifications: A qualified independent professional engineer not associated with Contractor or lighting equipment manufacturer, who is additionally LC by the National Council on Qualifications for the Lighting Professions, **as directed**.

6. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel" and AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
7. 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. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of luminaires, lamps, and luminaire alignment products and to correct misalignment that occurs subsequent to successful acceptance tests. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, and unauthorized repairs and alterations from special warranty coverage.
  - a. Luminaire Warranty: Luminaire and luminaire assembly (excluding fuses and lamps) shall be free from defects in materials and workmanship for a period of five years from date of Final Completion.
  - b. Lamp Warranty:
    - 1) Replace lamps and fuses that fail within 12 months from date of Final Completion.
    - 2) Provide replacement lamps for lamps that fail within the second 12 months from date of Final Completion.
  - c. Alignment Warranty: Accuracy of alignment of luminaires shall remain within specified illuminance uniformity ratios for a period of five years from date of successful completion of acceptance tests.
    - 1) Realign luminaires that become misaligned during the warranty period.
    - 2) Replace alignment products that fail within the warranty period.
    - 3) Verify successful realignment of luminaires by retesting as specified in "Field Quality Control" Article.

## 1.2 PRODUCTS

A. Luminaires, Lamps, And Ballasts

1. Luminaires: Listed and labeled, by an NRTL acceptable to authorities having jurisdiction, for compliance with UL 1598 for installation in wet locations.
  - a. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without using tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent their accidental falling during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lens.
  - b. Exposed Hardware: Stainless-steel latches, fasteners, and hinges.



- c. Spill-Light Control Devices: Internal louvers and external baffles furnished by manufacturer and designed for secure attachment to specific luminaire.
  - d. Luminaires for tennis courts shall be bracket-mounted, full-cutoff type with integral ballasts.
  - e. Lamps for Tennis Court Luminaires: Metal halide, rated 1000 W.
2. Ballast Mounting: Grouped in cabinets, remote from **OR** At, **as directed**, location of associated luminaires unless otherwise indicated.

#### B. Support Structures

1. Support-Structure Wind-Load Strength: Poles and other support structures, brackets, arms, appurtenances, bases, anchorages, and foundations shall comply with AASHTO LTS-4-M and shall be certified by manufacturers to withstand winds up to 100 mph (160 km/h) without permanent deflection or whipping.
2. Support-Structure Seismic Strength: Poles or other support structures, brackets, arms, appurtenances, bases, anchorages, and foundations shall be designed to prevent separation of components or fracture of poles, luminaire supports, or pole foundations during a seismic event.
3. Mountings, Fasteners, and Appurtenances:
  - a. Corrosion resistant, compatible with support components, and which shall not cause galvanic action at contact points.
    - 1) Steel Components: Hot-dip galvanized after fabrication, complying with ASTM A 123/A 123M.
    - 2) Mounting Hardware Fasteners: Hot-dip galvanized, complying with ASTM A 153/A 153M, or minimum 18-8 grade stainless steel.
  - b. Accommodate attachments and wiring of other indicated systems.
4. Concrete for Pole Foundations: 3000-psi (20.7-MPa), 28-day minimum compressive strength. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-place Concrete".
5. Direct-buried steel structures or poles shall not be used.

#### C. Power Distribution And Control

1. Wiring Method for Feeders, Subfeeders, Branch Circuits, and Control Wiring: Underground nonmetallic raceway; No. 10 AWG minimum conductor size for power wiring.
2. Overhead-, pole-, or structure-supported wiring and transformers are **OR** are not, **as directed**, permitted.
3. Electrical Enclosures Exposed to Weather: NEMA 250, Type 3R enclosure constructed from stainless steel **OR** corrosion-resistant material, **as directed**, with hinged doors fitted with padlock hasps or lockable latches.

#### D. Surge Protection

1. Surge Protection: Comply with requirements in Division 26 Section "Transient-voltage Suppression For Low-voltage Electrical Power Circuits" and include surge suppressors with the following requirements:
  - a. Panelboard type.
  - b. Nonmodular, with digital indicator lights and one set of dry contacts, **as directed**.
  - c. Peak Single-Impulse Surge Current Rating: **<Insert number>** kA per phase.

#### E. Pole And Base Protection

1. Pole Pads: Wraparound pad, with 4 inches (100 mm) of extra-firm polyfoam, 360-degree coverage of ground-mounted poles and supports, continuous hook-and-loop fastening, and not less than 72 inches (1820 mm) high.

### 1.3 EXECUTION

#### A. Installation



1. Use web fabric slings (not chain or cable) to raise and set structural members. Protect equipment during installation to prevent corrosion.
  2. Install poles and other structural units level, plumb, and square.
  3. Except for embedded structural members, grout void between pole base and foundation. Use nonshrinking or expanding concrete grout firmly packed in entire void space. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole. Nonshrink grout is specified in Division 05 Section "Metal Fabrications".
  4. Install pole pads at all poles inside playing field boundaries and when located within 20 feet (6 m) of the field boundary.
  5. Extend cast-in-place bolted base foundations 36 inches (914 mm) above grade, minimum.
  6. Install protective pipe bollards on two **OR** three, **as directed**, sides of each embedded pole installed in paved areas. See Division 05 Section "Metal Fabrications" for pipe bollards.
  7. Install controls and ballast housings in cabinets mounted on support structure at least 10 feet (3 m) above finished grade.
- B. Field Quality Control
1. Perform tests, inspections, and analysis according to IESNA RP-6 and IESNA LM-5 where applicable.
  2. Tests and Inspections:
    - a. After installing sports lighting system and after electrical circuits have been energized, perform proof-of-performance field measurements and analysis for compliance with requirements.
    - b. Playing and Other Designated Areas: Make field measurements at intersections of grids, dimensioned and located as specified in "Performance Requirements" Article and as described below:
      - 1) Baseball Fields: Measure at least 25 points of the infield and 87 points of the outfield. Extend the grid 15 feet (5 m) outside the foul lines, extending to outfield boundary or fence.
      - 2) Softball Fields: Measure at least 16 points of the infield and 48 points of the outfield. Extend the grid 15 feet (5 m) outside the foul lines, extending to outfield boundary.
      - 3) Football Fields: Lighted area is 180 by 360 feet (55 by 110 m). Measure at least 91 points.
      - 4) Soccer Fields: Lighted area is 210 by 370 feet (64 by 113 m). Measure at least 91 points.
      - 5) Tennis Courts: Measure at least 30 points for a double court.
    - c. Make field measurements at established test points in areas of concern for spill light and glare.
    - d. Perform analysis to demonstrate correlation of field measurements with specified illumination quality and quantity values and corresponding computer-generated values that were submitted with engineered design documents. Submit a report of the analysis. For computer-generated values, use manufacturer's lamp lumens that are adjusted to lamp age at time of field testing.
  3. Correction of Illumination Deficiencies for Playing Areas: Make corrections to illumination quality or quantity, measured in field quality-control tests, that varies from specified illumination criteria by plus or minus 10 percent.
    - a. Add or replace luminaires, or change mounting height, revise aiming, or install louvers, shields, or baffles.
    - b. If luminaires are added or mounting height is changed, revise aiming and recalculate and modify or replace support structures if indicated.
    - c. Do not replace luminaires with units of higher or lower wattage without the Owner's approval.
    - d. Retest as specified above after repairs, adjustments, or replacements are made.
    - e. Report results in writing.



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4. Correction of Excessive Illumination in Spill-Light-Critical Areas: If measurements indicate that specified limits for spill light are exceeded, make corrections to illumination quantity, measured in field quality-control tests, that reduce levels to within specified maximum values.
    - a. Replace luminaires, or change mounting heights, revise aiming, or install louvers, shields, or baffles.
    - b. Obtain the Owner's approval to replace luminaires with units of higher or lower wattage.
    - c. If mounting height is changed, revise aiming and recalculate and modify or replace support structures if indicated.
    - d. Retest as specified above after repairs, adjustments, or replacements are made.
    - e. Report results in writing.
  5. Sports lighting will be considered defective if it does not pass tests and inspections.
  6. Prepare test and inspection reports.

C. Demonstration

1. Train the Owner's maintenance personnel to adjust, operate, and maintain exterior athletic lighting.

END OF SECTION 26 55 68 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
26 56 13 00	01 22 16 00	No Specification Required
26 56 13 00	02 84 33 00	Overhead Electrical Distribution
26 56 13 00	02 84 16 00b	Exterior Lighting
26 56 19 00	02 84 16 00b	Exterior Lighting
26 56 23 00	01 22 16 00	No Specification Required
26 56 23 00	02 84 33 00	Overhead Electrical Distribution
26 56 23 00	02 84 16 00a	Interior Lighting
26 56 23 00	02 84 16 00b	Exterior Lighting
26 56 26 00	01 22 16 00	No Specification Required
26 56 26 00	02 84 16 00b	Exterior Lighting
26 56 33 00	02 84 16 00a	Interior Lighting
26 56 33 00	02 84 16 00b	Exterior Lighting
26 56 36 00	02 84 16 00b	Exterior Lighting



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**SECTION 27 05 26 00 - 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 27 05 26 00



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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



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
27 11 16 00	27 05 26 00	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 "ST<sup>TM</sup> 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 (Sicor) 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. Spices 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, arid 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 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



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
27 11 19 00	27 11 16 00	Underground Storage Tank Removal
27 11 19 00	27 05 26 00	Intercommunications and Program Systems
27 11 23 00	27 05 26 00	Intercommunications and Program Systems
27 14 13 13	26 05 13 00	Conductors And Cables
27 14 13 13	26 05 13 00a	Undercarpet Cables
27 14 13 13	26 05 13 00b	Medium-Voltage Cables
27 14 13 13	27 05 26 00	Intercommunications and Program Systems
27 14 13 16	26 05 13 00	Conductors And Cables
27 14 13 16	26 05 13 00a	Undercarpet Cables
27 14 13 16	26 05 19 16c	Control-Voltage Electrical Power Cables
27 14 13 16	26 05 13 00b	Medium-Voltage Cables
27 14 23 13	27 11 19 00	Loose-Tube Gel-Filled Fiber Optic Cables
27 14 33 16	26 05 13 00	Conductors And Cables
27 14 33 16	26 05 13 00a	Undercarpet Cables
27 14 33 16	26 05 19 16c	Control-Voltage Electrical Power Cables
27 14 33 16	26 05 13 00b	Medium-Voltage Cables
27 14 43 00	27 05 26 00	Intercommunications and Program Systems
27 14 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 13 00	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 21 16 00	27 05 26 00	Intercommunications and Program Systems
27 31 13 00	27 11 16 00	Underground Storage Tank Removal
27 31 13 00	27 05 26 00	Intercommunications and Program Systems
27 32 19 00	27 11 16 00	Underground Storage Tank Removal
27 32 19 00	26 05 33 16a	Wiring Devices
27 32 19 00	27 05 26 00	Intercommunications and Program Systems
27 32 26 00	27 11 16 00	Underground Storage Tank Removal
27 32 26 00	27 05 26 00	Intercommunications and Program Systems



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**SECTION 27 51 33 00 - 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 33 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
27 51 33 00	26 33 43 00b	Public Address and Mass Notification Systems
27 52 23 00	26 33 43 00a	Nurse Call



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## SECTION 27 53 13 00 - 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 00



## 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, balanced-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.
  - 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 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."



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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."

END OF SECTION 28 16 11 00a



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
28 16 11 00	27 51 33 00	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 00 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.

END OF SECTION 28 21 00 00



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**SECTION 28 42 00 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 overload 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 Pullulert 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 21 33 - 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 33



## SECTION 28 46 21 33a - 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, **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, **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.

END OF SECTION 28 46 21 33a



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
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 01 20 00 - 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 01 20 00



## SECTION 31 05 13 00 - SUBDRAINAGE

### 1.1 GENERAL

#### A. Description Of Work

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

#### B. Summary

1. Section Includes:
  - a. Perforated-wall pipe and fittings.
  - b. Drainage conduits.
  - c. Drainage panels.
  - d. Geotextile filter fabrics.

#### C. Submittals

1. Drainage conduits, including rated capacities.
2. Drainage panels, including rated capacities.
3. Geotextile filter fabrics.

### 1.2 PRODUCTS

#### A. Perforated-Wall Pipes And Fittings

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

#### B. Drainage Conduits

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



2. Multipipe Drainage Conduits: Prefabricated geocomposite with interconnected, corrugated, perforated-pipe core molded from HDPE complying with ASTM D 1248 and wrapped in geotextile filter fabric.
  - a. Nominal Size: 6 inches (152 mm) high by approximately 1-1/4 inches (31 mm) thick.
    - 1) Minimum In-Plane Flow: 15 gpm (57 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - b. Nominal Size: 12 inches (305 mm) high by approximately 1-1/4 inches (31 mm) thick.
    - 1) Minimum In-Plane Flow: 30 gpm (114 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - c. Nominal Size: 18 inches (457 mm) high by approximately 1-1/4 inches (31 mm) thick.
    - 1) Minimum In-Plane Flow: 45 gpm (170 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - d. Filter Fabric: Nonwoven, needle-punched geotextile.
  - e. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.
  - f. Couplings: HDPE.
3. Single-Pipe Drainage Conduits: Prefabricated geocomposite with perforated corrugated core molded from HDPE complying with ASTM D 3350 and wrapped in geotextile filter fabric.
  - a. Nominal Size: 12 inches (305 mm) high by approximately 1 inch (25 mm) thick.
    - 1) Minimum In-Plane Flow: 30 gpm (114 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - b. Nominal Size: 18 inches (457 mm) high by approximately 1 inch (25 mm) thick.
    - 1) Minimum In-Plane Flow: 45 gpm (170 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - c. Filter Fabric: Nonwoven, PP geotextile.
  - d. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.
  - e. Couplings: Corrugated HDPE band.
4. Mesh Fabric Drainage Conduits: Prefabricated geocomposite with plastic-filament drainage core wrapped in geotextile filter fabric. Include fittings for bends and connection to drainage piping.
  - a. Nominal Size: 6 inches (2-mm) high by approximately 0.9 inch (23 mm) thick.
    - 1) Minimum In-Plane Flow: 2.4 gpm (9.1 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - b. Filter Fabric: Nonwoven geotextile made of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.
5. Ring Fabric Drainage Conduits: Drainage conduit with HDPE-rings-in-grid-pattern drainage core, for field-applied geotextile filter fabric. Include fittings for bends and connection to drainage piping.
  - a. Nominal Size: 18 inches (0.5 m) high by 1 inch (25 mm) thick.
    - 1) Minimum In-Plane Flow: 82 gpm (310 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - b. Nominal Size: 36 inches (1 m) high by 1 inch (25 mm) thick.
    - 1) Minimum In-Plane Flow: 164 gpm (621 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - c. Filter Fabric: Specified in Part 1.2 "Geotextile Filter Fabrics" Article.

#### C. Drainage Panels

1. Molded-Sheet Drainage Panels: Prefabricated geocomposite, 36 to 60 inches (915 to 1525 mm) wide with drainage core faced with geotextile filter fabric.
  - a. Drainage Core: Three-dimensional, nonbiodegradable, molded PP.
    - 1) Minimum Compressive Strength: 10,000 lbf/sq. ft. (479 kPa) **OR** 15,000 lbf/sq. ft. (718 kPa) **OR** 18,000 lbf/sq. ft. (862 kPa) **OR** 21,000 lbf/sq. ft. (1005 kPa), **as directed**, when tested according to ASTM D 1621.



- 2) Minimum In-Plane Flow Rate: 2.8 gpm/ft. (35 L/min. per m) **OR** 7 gpm/ft. (87 L/min. per m) **OR** 15 gpm/ft. (188 L/min. per m), **as directed**, of unit width at hydraulic gradient of 1.0 and compressive stress of 25 psig (172 kPa) when tested according to ASTM D 4716.
- b. Filter Fabric: Nonwoven needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined according to AASHTO M 288:
  - 1) Survivability: Class 1 **OR** 2 **OR** 3, **as directed**.
  - 2) Apparent Opening Size: No. 40 (0.425-mm) **OR** No. 60 (0.25-mm) **OR** No. 70 (0.212-mm), **as directed**, sieve, maximum.
  - 3) Permittivity: 0.5 **OR** 0.2 **OR** 0.1, **as directed**, per second, minimum.
- c. Filter Fabric: Woven geotextile fabric, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation less than 50 percent; complying with the following properties determined according to AASHTO M 288:
  - 1) Survivability: Class 1 **OR** 2 **OR** 3, **as directed**.
  - 2) Apparent Opening Size: No. 40 (0.425-mm) **OR** No. 60 (0.25-mm) **OR** No. 70 (0.212-mm) **OR** No. 30 (0.6-mm), **as directed**, sieve, maximum.
  - 3) Permittivity: 0.5 **OR** 0.2 **OR** 0.1 **OR** 0.02, **as directed**, per second, minimum.
- d. Film Backing: Polymeric film bonded to drainage core surface.
2. Mesh Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.
  - a. Drainage Core: Open-construction, resilient, approximately 0.4-inch- (10.2-mm-) thick, plastic-filament mesh.
    - 1) Minimum In-Plane Flow Rate: 2.4 gpm/ft. (30 L/min. per m) of unit width at hydraulic gradient of 1.0 and normal pressure of 25 psig (172 kPa) when tested according to ASTM D 4716.
  - b. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.
3. Net Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.
  - a. Drainage Core: 3-dimensional, PE nonwoven-strand geonet, approximately 0.25-inch- (6-mm-) thick.
    - 1) Minimum In-Plane Flow Rate: 2.4 gpm/ft. (30 L/min. per m) **OR** 5 gpm/ft. (62 L/min. per m), **as directed**, of unit width at hydraulic gradient of 1.0 and normal pressure of 25 psig (172 kPa) when tested according to ASTM D 4716.
  - b. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.
4. Ring Fabric Drainage Panels: Drainage-core panel for field application of geotextile filter fabric.
  - a. Drainage Core: 3-dimensional, HDPE rings in grid pattern, approximately 1 inch (25 mm) thick.
    - 1) Minimum In-Plane Flow Rate: 40 gpm/ft. (500 L/min. per m) of unit width at hydraulic gradient of 1.0 and normal pressure of 25 psig (172 kPa) when tested according to ASTM D 4716.
5. Fabric-Covered Insulated Drainage Panels: Extruded PS board insulation complying with ASTM C 578; fabricated with shiplap **OR** tongue-and-groove, **as directed**, edges and with one side having grooved drainage channels; unfaced **OR** ; faced with geotextile filter fabric, **as directed**.
  - a. Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) minimum density and 25-psig (172-kPa) minimum compressive strength.
  - b. Type VI, 1.8-lb/cu. ft. (29-kg/cu. m) minimum density and 40-psig (276-kPa) minimum compressive strength.
  - c. Minimum In-Plane Flow Rate: 9 gpm/ft. (112 L/min. per m) of unit width when tested according to ASTM D 4716.



- d. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.
6. Noncovered Insulated Drainage Panels: Extruded PS board insulation complying with ASTM C 578; fabricated with rabbeted edges and with one side having ribbed drainage channels.
  - a. Type VI, 1.8-lb/cu. ft. (29-kg/cu. m) minimum density and 40-psig (276-kPa) minimum compressive strength.
  - b. Type VII, 2.2-lb/cu. ft. (35-kg/cu. m) minimum density and 60-psig (414-kPa) minimum compressive strength.
  - c. Minimum In-Plane Flow Rate: 9 gpm/ft. (112 L/min. per m) of unit width when tested according to ASTM D 4716.
7. Expanded PS Insulated Drainage Panels: PS bead board insulation; panels are 4 inches (102 mm) thick by 48 inches (1220 mm) wide and faced with geotextile filter fabric.
  - a. Density: 2 lb/cu. ft. (32 kg/cu. m).
  - b. Compressive Strength: 800 lbf/sq. ft. (38 kPa).
  - c. Minimum In-Plane Flow Rate: 3 gpm/ft. (37 L/min. per m) of unit width when tested according to ASTM D 4716.
  - d. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.

#### D. Soil Materials

1. Soil materials are specified in Division 31 Section "Earth Moving".

#### E. Waterproofing Felts

1. Material: Comply with ASTM D 226, Type I, asphalt **OR** ASTM D 227, coal-tar, **as directed**, -saturated organic felt.

#### F. Geotextile Filter Fabrics

1. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. (4480 to 13 440 L/min. per sq. m) when tested according to ASTM D 4491.
  - a. Structure Type: Nonwoven, needle-punched continuous filament.
    - 1) Survivability: AASHTO **M 288 Class 2**.
    - 2) Style(s): Flat **OR** sock, **as directed**.

### 1.3 EXECUTION

#### A. Earthwork

1. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving".

#### B. Foundation Drainage Installation

1. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches (150 mm) deep and 12 inches (300 mm) wide.
2. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
3. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
4. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
5. Install drainage piping as indicated in Article 1.3 "Piping Installation" for foundation subdrainage.
6. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
7. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.



8. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
9. Place layer of flat-style geotextile filter fabric **OR** waterproofing felt, **as directed**, over top of drainage course, overlapping edges at least 4 inches (100 mm).
10. Install drainage panels on foundation walls as follows:
  - a. Coordinate placement with other drainage materials.
  - b. Lay perforated drainage pipe at base of footing. Install as indicated in Article 1.3 "Piping Installation."
  - c. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
  - d. Attach panels to wall beginning at subdrainage pipe. Place and secure molded-sheet drainage panels, with geotextile facing away from wall.
11. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

C. Underslab Drainage Installation

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

D. Retaining-Wall Drainage Installation

1. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
2. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than 4 inches (100 mm).
3. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
4. Install drainage piping as indicated in Article 1.3 "Piping Installation" for retaining-wall subdrainage.
5. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
6. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.
7. Place drainage course in layers not exceeding 3 inches (75 mm) in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.
8. Place layer of flat-style geotextile filter fabric **OR** waterproofing felt, **as directed**, over top of drainage course, overlapping edges at least 4 inches (100 mm).
9. Install drainage panels on walls as follows:



- a. Coordinate placement with other drainage materials.
  - b. Lay perforated drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
  - c. If weep holes are used instead of drainage pipe, cut 1/2-inch- (13-mm-) diameter holes on core side at weep-hole locations. Do not cut fabric.
  - d. Mark horizontal chalk line on wall at a point 6 inches (150 mm) less than panel width above footing bottom. Before marking wall, subtract footing width.
  - e. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
  - f. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Place nails from 2 to 6 inches (50 to 150 mm) below top of panel, approximately 48 inches (1200 mm) apart. Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
  - g. If another panel is required on same row, cut away 4 inches (100 mm) of installed panel core and wrap fabric over new panel.
  - h. If additional rows of panel are required, overlap lower panel with 4 inches (100 mm) of fabric.
  - i. Cut panel as necessary to keep top 12 inches (300 mm) below finish grade.
  - j. For inside corners, bend panel. For outside corners, cut core to provide 3 inches (75 mm) for overlap.
10. Fill to Grade: Place satisfactory soil fill material over compacted drainage course . Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Fill to finish grade.

#### E. Landscaping Drainage Installation

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

#### F. Piping Installation

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



- d. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of 36 inches (915 mm), unless otherwise indicated.
  - e. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches (915 mm), unless otherwise indicated.
  - f. Lay perforated pipe with perforations down.
  - g. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
2. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
  3. Install thermoplastic piping according to ASTM D 2321.
- G. Pipe Joint Construction
1. Join perforated PE pipe and fittings with couplings according to ASTM D 3212 with loose banded, coupled, or push-on joints.
  2. Join perforated PVC sewer pipe and fittings according to ASTM D 3212 with loose bell-and-spigot, push-on joints.
  3. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.
- 1.4 Backwater Valve Installation
1. Comply with requirements for backwater valves specified in Division 2 Section "Storm Drainage."
  2. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.
  3. Install horizontal backwater valves in piping in manholes or pits where indicated.
- B. Cleanout Installation
1. Comply with requirements for cleanouts specified in Division 2 Section "Storm Drainage."
  2. Cleanouts for Foundation, Retaining-Wall, and Landscaping Subdrainage:
    - a. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
    - b. In vehicular-traffic areas, use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches (450 by 450 by 300 mm) in depth. Set top of cleanout flush with grade. Cast-iron pipe may also be used for cleanouts in nonvehicular-traffic areas.
    - c. In nonvehicular-traffic areas, use NPS 4 (DN 100) cast-iron **OR** PVC, **as directed**, pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches (300 by 300 by 100 mm) in depth. Set top of cleanout plug 1 inch (25 mm) above grade.
  3. Cleanouts for Underslab Subdrainage:
    - a. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
    - b. Use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.
- C. Connections
1. Comply with requirements for piping specified in Division 2 Section "Storm Drainage." Drawings indicate general arrangement of piping, fittings, and specialties.
  2. Connect low elevations of subdrainage system to building's solid-wall-piping storm drainage system.



3. Where required, connect low elevations of foundation **OR** Underslab, **as directed**, subdrainage to stormwater sump pumps.

D. Identification

1. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Division 31 Section "Earth Moving".
  - a. Install PE warning tape or detectable warning tape over ferrous piping.
  - b. Install detectable warning tape over nonferrous piping and over edges of underground structures.

E. Field Quality Control

1. Tests and Inspections:
  - a. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
  - b. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.
2. Drain piping will be considered defective if it does not pass tests and inspections.
3. Prepare test and inspection reports.

F. Cleaning

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

END OF SECTION 31 05 13 00



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
31 05 13 00	31 01 20 00	Earthwork
31 05 16 00	31 01 20 00	Earthwork
31 05 16 00	31 05 13 00	Subdrainage



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## SECTION 31 23 16 13 - 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.



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- 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 16 13



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
31 23 16 13	31 01 20 00	Earthwork

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**SECTION 31 23 16 26 - 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
  - a. Soil materials of any classification shall not have a moisture content at the time of compaction that would be classified as unsatisfactory soil materials in the paragraph entitled, "Definitions."
  - b. Results of density of soil-in-place tests shall be considered satisfactory if the average of any group of four consecutive density tests which may be selected is in each instance equal to or greater than the specified density, and if no density test has a value more than 2 percentage points below the specified density.

E. Use Of Explosives:

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

F. Protection Of Persons And Property

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

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

H. Existing Conditions

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



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

## 1.2 PRODUCTS

### A. Materials

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

## 1.3 EXECUTION

### A. Blasting:

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

**OR**

Blasting is not required or permitted.

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

### C. Excavation

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



- and filling shall be performed in a manner and sequence that will provide proper drainage at all times. Material required for fill or embankment in excess of that produced by excavation within the grading limits shall be excavated from the borrow areas indicated or from other approved areas selected by the Owner.
4. Excavation of Ditches, Gutters, and Channels: Care shall be taken not to excavate ditches and gutters below grades shown. Excessive open-ditch or gutter excavation shall be backfilled with suitable materials to grades indicated at no additional cost. Materials excavated shall be disposed as indicated, except that in no case shall material be deposited less than 3 ft. (1 m) from the edge of a ditch. Contractor shall maintain excavations free from debris until final acceptance of the work.
  5. Excavation for Drainage Structures
    - a. Dimensions and elevations of footings and foundation excavations indicated are only approximate and may be changed if necessary to ensure adequate foundation support. Trenches and foundation pits shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations. Rock or other hard foundation material shall be cleaned of loose debris and cut to a firm surface, either level, stepped, or serrated. Loose disintegrated rock and thin strata shall be removed. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before concrete or masonry is to be placed.
    - b. Where pile foundations are to be used, the excavation of each pit shall be stopped at an elevation 1 ft. (300 mm) above the base of the footing, as specified, before piles are driven. After pile driving has been completed, loose and displaced material shall be removed and excavation completed, leaving a smooth, solid, undisturbed surface to receive concrete or masonry.
  6. Protection or Removal of Utility Lines: Existing Utilities that are indicated to be retained, or the locations of which have been ascertained from 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.

31 - Earthwork



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END OF SECTION 31 23 16 26



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
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31 23 16 33	31 01 20 00	Earthwork
31 23 16 36	31 23 16 13	Excavation Support And Protection
31 23 16 36	31 01 20 00	Earthwork
31 23 16 43	31 23 16 13	Excavation Support And Protection
31 23 16 43	31 01 20 00	Earthwork



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**SECTION 31 23 19 00 - PIPED UTILITIES BASIC MATERIALS AND METHODS****1.1 GENERAL****A. Description Of Work**

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

**B. Summary**

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

**C. Definitions**

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

**D. Submittals**

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

**E. Quality Assurance**

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



F. Delivery, Storage, And Handling

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

1.2 PRODUCTS

A. Piping Joining Materials

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

B. Transition Fittings

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



- C. Dielectric Fittings
1. Dielectric Fittings, General: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
  2. Dielectric Unions:
    - a. Description: Factory fabricated, union, NPS 2 (DN 50) and smaller.
      - 1) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**, at 180 deg F (82 deg C).
      - 2) End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.
  3. Dielectric Flanges:
    - a. Description: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and larger.
      - 1) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
      - 2) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
  4. Dielectric-Flange Kits:
    - a. Description: Nonconducting materials for field assembly of companion flanges, NPS 2-1/2 (DN 65) and larger.
      - 1) Pressure Rating: 150 psig (1035 kPa) minimum.
      - 2) Gasket: Neoprene or phenolic.
      - 3) Bolt Sleeves: Phenolic or polyethylene.
      - 4) Washers: Phenolic with steel backing washers.
  5. Dielectric Couplings:
    - a. Description: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, NPS 3 (DN 80) and smaller.
      - 1) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
      - 2) End Connections: Threaded.
  6. Dielectric Nipples:
    - a. Description: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining.
      - 1) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
      - 2) End Connections: Threaded or grooved.
- D. Sleeves
1. Mechanical sleeve seals for pipe penetrations are specified in Division 22 Section "Common Work Results For Plumbing".
  2. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
  3. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, plain ends.
  4. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
  5. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
  6. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.
  7. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- E. Identification Devices
1. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
    - a. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
    - b. Location: Accessible and visible.
  2. Stencils: Standard stencils prepared with letter sizes complying with recommendations in ASME A13.1. Minimum letter height is 1-1/4 inches (30 mm) for ducts, and 3/4 inch (20 mm) for access door signs and similar operational instructions.
    - a. Material: Fiberboard **OR** Brass, **as directed**.



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



- g. Size: 2-1/2 by 4 inches (65 by 100 mm) for control devices, dampers, and valves; 4-1/2 by 6 inches (115 by 150 mm) for equipment.
14. Plasticized Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.
  - a. Size: 3-1/4 by 5-5/8 inches (83 by 143 mm).
  - b. Fasteners: Brass grommets and wire.
  - c. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
15. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.
  - a. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

#### F. Grout

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

#### G. Flowable Fill

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

### 1.3 EXECUTION

#### A. Piped Utility Demolition

1. Refer to Division 01 Section(s) "Cutting And Patching" AND Division 02 Section(s) "Selective Structure Demolition" for general demolition requirements and procedures.
2. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.
  - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  - b. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
  - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.
  - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to the Owner.
3. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

#### B. Dielectric Fitting Applications

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



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

#### C. Piping Installation

1. Install piping according to the following requirements and Division 33 specifying piping systems.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.
3. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
4. Install piping to permit valve servicing.
5. Install piping at indicated slopes.
6. Install piping free of sags and bends.
7. Install fittings for changes in direction and branch connections.
8. Select system components with pressure rating equal to or greater than system operating pressure.
9. Sleeves are not required for core-drilled holes, unless directed otherwise.
10. Permanent sleeves are not required for holes formed by removable PE sleeves, unless directed otherwise.
11. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
  - a. Cut sleeves to length for mounting flush with both surfaces.
    - 1) Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
  - b. Install sleeves in new walls and slabs as new walls and slabs are constructed.
    - 1) PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
    - 2) Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
12. Verify final equipment locations for roughing-in.
13. Refer to equipment specifications in other Sections for roughing-in requirements.

#### D. Piping Joint Construction

1. Join pipe and fittings according to the following requirements and Division 33 specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
5. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1.1 "Quality Assurance" Article.
6. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
7. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.



8. Soldered Joints: Apply ASTM B 813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.
  9. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
  10. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.
  11. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    - a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    - b. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
    - c. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
    - d. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
    - e. PVC Nonpressure Piping: Join according to ASTM D 2855.
    - f. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
  12. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
  13. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
  14. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
    - a. Plain-End PE Pipe and Fittings: Use butt fusion.
    - b. Plain-End PE Pipe and Socket Fittings: Use socket fusion.
  15. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.
- E. Piping Connections
1. Make connections according to the following, unless otherwise indicated:
    - a. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
    - b. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
    - c. Install dielectric fittings at connections of dissimilar metal pipes.
- F. Equipment Installation
1. Install equipment level and plumb, unless otherwise indicated.
  2. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.
  3. Install equipment to allow right of way to piping systems installed at required slope.
- G. Painting
1. Painting of piped utility systems, equipment, and components is specified in Division 09.
  2. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- H. Identification
1. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
    - a. Stenciled Markers: According to ASME A13.1.
    - b. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
    - c. Locate pipe markers on exposed piping according to the following:
      - 1) Near each valve and control device.



- 2) Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
  - 3) Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
  - 4) At manholes and similar access points that permit view of concealed piping.
  - 5) Near major equipment items and other points of origination and termination.
2. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.
    - a. Lettering Size: Minimum 1/4 inch (6.4 mm) high for name of unit if viewing distance is less than 24 inches (610 mm), 1/2 inch (13 mm) high for distances up to 72 inches (1800 mm), and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
    - b. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
  3. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

#### I. Concrete Bases

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

#### J. Erection Of Metal Supports And Anchorages

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

#### K. Grouting

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

END OF SECTION 31 23 19 00

**SECTION 31 23 19 00a - DEWATERING****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for dewatering. Products shall be as follows or as directed by the Owner. Installation procedures 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. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
  - a. Delegated Design: Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
  - b. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
  - c. Prevent surface water from entering excavations by grading, dikes, or other means.
  - d. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
  - e. Remove dewatering system when no longer required for construction.

**C. Submittals**

1. Shop Drawings: For dewatering system. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
  - a. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
  - b. Include a written plan for dewatering operations including control procedures to be adopted if dewatering problems arise.
2. Delegated-Design Submittal: For dewatering 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. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.
2. 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, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
  - a. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify the Owner if



changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

## 1.2 PRODUCTS (Not Used)

## 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 dewatering operations.
  - a. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
  - b. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
2. Install dewatering system 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. Provide temporary grading to facilitate dewatering and control of surface water.
4. Monitor dewatering systems continuously.
5. Promptly repair damages to adjacent facilities caused by dewatering.
6. Protect and maintain temporary erosion and sedimentation controls, which are specified in Division 31 Section "Site Clearing" during dewatering operations.

### B. Installation

1. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
  - a. Space well points or wells at intervals required to provide sufficient dewatering.
  - b. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
2. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
3. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
  - a. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
4. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
  - a. Maintain piezometric water level a minimum of 24 inches (600 mm) **OR** 60 inches (1500 mm), **as directed**, below surface of excavation.
5. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
6. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to the Owner.



- 
- a. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches (900 mm) below overlying construction.
  7. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION 31 23 19 00a



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
31 23 23 23	31 01 20 00	Earthwork

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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 32 33 00	01 32 33 00, 01 32 33 00a, 01 32 33 00b, 01 32 33 00c, 01 32 33 00d
01 51 13 00	01 51 13 00
01 52 13 00	01 52 13 00, 01 22 16 00
01 52 19 00	01 22 16 00, 01 52 13 00
01 54 23 00	01 54 23 00, 01 54 23 00a, 01 22 16 00
01 54 26 00	01 22 16 00
01 54 29 00	01 22 16 00
01 55 23 00	01 22 16 00
01 55 26 00	01 22 16 00
01 56 16 00	01 22 16 00
01 56 26 00	01 56 26 00, 01 56 26 00a, 01 22 16 00
01 56 29 00	01 22 16 00
01 56 33 00	01 22 16 00
01 56 39 00	01 22 16 00
01 57 13 00	01 56 26 00
01 58 13 00	01 22 16 00
01 66 19 00	01 22 16 00
01 71 13 00	01 22 16 00
01 71 23 16	01 71 23 16
01 74 16 00	01 22 16 00
01 74 19 00	01 74 19 00
02 81 00 00	02 81 00 00, 02 81 00 00a
02 82 16 00	02 82 16 00
02 82 33 00	02 82 33 00, 02 82 33 00a, 01 22 16 00, 02 81 00 00a, 02 82 16 00
02 83 19 13	02 83 19 13, 02 83 19 13a, 02 83 19 13b, 02 83 19 13c, 02 82 33 00, 02 82 33 00a
02 83 33 13	02 83 19 13, 02 83 19 13a, 02 83 19 13b, 02 83 19 13c
02 84 16 00	02 84 16 00, 02 84 16 00a, 02 84 16 00b
02 84 33 00	02 84 33 00
02 87 13 33	02 87 13 33
02 87 16 13	02 87 16 13
02 89 00 00	01 22 16 00, 02 83 19 13, 02 83 19 13a, 02 83 19 13b, 02 83 19 13c
05 05 19 00	05 05 19 00, 01 22 16 00
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