

193D SPECIAL OPERATIONS WING
Pennsylvania Air National Guard
Harrisburg ANGB
Middletown, Pennsylvania

**SOF CONSTRUCT
SIMULATOR FACILITY
MC-130J**

Project No: SHYQ149104

SPECIFICATIONS



BID DOCUMENTS

JANUARY 2026



**GANNETT
FLEMING**

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NOTE: THIS PROJECT MANUAL IS ARRANGED IN THE NATIONALLY RECOGNIZED CONSTRUCTION SPECIFICATION INSTITUTE FORMAT (CSI). HOWEVER, ONLY THE APPLICABLE SECTIONS OF CERTAIN DIVISIONS ARE INCLUDED WHICH RESULTS IN THE SECTION NUMBERING NOT BEING CONSECUTIVE.

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SECTION 01 00 00
REQUIREMENTS OF PENNSYLVANIA AIR NATIONAL GUARD

PART 1 GENERAL**1.01 SUMMARY**

- A. Section Includes
 - 1. Work Schedule.
 - 2. Hazardous Material Usage.
 - 3. Covering of Debris.
 - 4. Utility Line Marking.
 - 5. Environmental Protection.

1.02 WORK SCHEDULE

- A. All work shall be accomplished during normal working hours (0700 to 1600 hours) exclusive of Saturdays, Sundays, and federal holidays unless other times are approved by the Government, or otherwise stated in the Contract. Coordinate the work schedule with the Government.
- B. The Contracting Officer or designated representative will approve any changes to these hours. Requests to work outside normal duty hours will be considered on an individual basis and not for the entire project. Refusal of a contractor's request to conduct work on weekends, holidays, or regularly scheduled days off does not constitute a government caused delay. Generally, work in an occupied building will not be allowed, while work in an unoccupied building or outdoors may be allowed, depending on the planned work.

1.03 HAZARDOUS MATERIAL USAGE

- A. The Contractor shall establish a hazardous material (HM) storage and distribution system when HM is to be used. All HM required to support the contract shall be reported to the Hazardous Material Pharmacy (HMP) using the Contractor HM Identification Form. The Form may be altered to enhance tracking. The Contractor HM Identification Form will be provided to the Contractor at or prior to the Preconstruction meeting. Additional HM needed by the Contractor shall be identified to the Government for approval by the HMP. See Supplement Contractor Hazardous Material Identification Form.
- B. The Contractor planning to use HM for the work must register with the base HMP prior to start of work in order to support the installation's compliance with Executive Order 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements.
- C. The Contractor shall maintain Contractor HM Identification Form for HM on the jobsite for inspection/verification.
- D. Government will verify that the HM identified to HMP is the only HM in use on the jobsite.
- E. Contractors shall Provide the HMP:
 - 1. Provide a list of each material and quantity of material for all proposed HM. Hazardous Material (HM) shall be construed to mean any item that is:
 - a. A health hazard or physical hazard as defined in 29 CFR, 1910.1200(c).
 - b. Regulated in its disposal by EPA under 40 CFR.
 - c. Hazardous as defined by DOT regulations under 49 CFR.
 - d. Hazardous as defined by the Dangerous Goods Regulations of the International Air Transport Association.
 - 2. Provide a material safety data sheet (MSDS) for each item on the HM list.
 - 3. Typical examples of hazardous materials used on the jobsite include, but are not limited to:
 - a. Petroleum based liquids/gases (gasoline, kerosene, diesel, propane, butane, acetylene, etc.).
 - b. Explosives.
 - c. Adhesives and glues.
 - d. Shot charges for anchor systems.

- e. Volatile solvents (such as PVC cleaner and glues, paint thinners).
 - f. Non-water-based paints.
 - g. Liquid sealants.
 - h. Epoxies and coating systems.
 - i. Acidic or alkali cleaners.
- F. The Contractor shall establish a construction specific HM storage and issue location that fully complies with federal, state, and local environmental regulations. Materials issued shall be tracked for quantities used. Unused materials shall be inventoried and removed from the ANG installation prior to closeout of the contract or expiration date of the HM. Reports of materials delivered, used, and removed from the installation shall be submitted to the Government monthly and prior to contract closeout.
- G. The Contractor shall comply with all federal, state, and local environmental standards.
- H. The Contractor shall accompany the Government and the installation Environmental Manager (EM) on project closeout inspection to ensure all used and unused HM was removed from the installation. This requirement shall not be a punch list item and must be accomplished prior to the government accepting beneficial occupancy of the facility or construction item. See Supplement Contractor Hazardous Material Identification Form Closeout Procedures.

1.04 COVERING OF DEBRIS

- A. The Contractor and Subcontractor shall be responsible to cover all loads of debris before hauling them off the site. The Contractor and Subcontractor shall provide a covering to keep the debris on the truck; however, in the event debris does fall out of the truck while hauling the Contractor shall immediately clean up all debris.

1.05 UTILITY LINE MARKING

- A. Contractor shall provide and install warning tapes within one foot of all new utilities placed underground.
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, place continuously along length of all utilities; 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.

1.06 ENVIRONMENTAL PROTECTION

- A. The Contractor shall abide by the environmental requirements of the State of Pennsylvania and the Pennsylvania Department of Environmental Protection. The requirements shall be incorporated into the waste disposal plan in accordance with Section 01 41 00, Environmental Protection.
- B. Vehicles and other powered equipment shall meet local and state air quality regulations for emissions. They shall be mechanically sound and have all seals, grease rings, and other containment systems in place to ensure against leakage. Drip pans shall be maintained such that overflow and spills do not occur. There shall be no activities for equipment maintenance including oil changes, filter replacements, or hydraulic equipment repair performed on Government Property.
- C. All solid waste shall be collected and disposed of off government property on a daily basis. There shall be no accumulation of solid waste unless properly containerized or put within a fenced area to prevent material being blown about by the wind.
- D. Paint Cans: Only empty liquid paint cans shall be allowed in Contractor controlled dumpsters. No aerosol cans may be disposed of in dumpsters. A paint can is considered empty if paint comprises less than 1 inch or 3 percent by weight of the total capacity of the container,

whichever is less. If the residue in the container exceeds these limits, contact the Government for disposal instructions.

- E. Asphalt debris scheduled for removal shall be disposed of off site.
- F. Excavated debris excluding hazardous or special wastes such as asbestos, contaminated soils, underground utilities, paints, or solvents shall be disposed of off the site.
- G. All solid waste not specifically noted above shall be removed from Government property by the Contractor.
- H. All buried utilities scheduled for removal shall be removed from Government property by the Contractor.
- I. If at anytime, an authorized inspector for the Base Civil Engineer thinks that regulatory requirements are not being followed, the Base Civil Engineer reserves the right to notify the Contracting Officer and recommend corrective action.

1.07 SUPPLEMENTS

- A. The supplements listed below and appended to this section, are a part of this Specification.
 - 1. Contractor Hazardous Material Identification Form.
 - 2. Contractor Hazardous Material Identification Form Closeout.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

**SECTION 01 06 00
SAFETY POLICIES AND PROCEDURES**

PART 1 GENERAL**1.01 SUMMARY**

- A. Section Includes
 - 1. Contractor required health and safety plan. See this Section and Section 01 41 00, Environmental Protection, for sample requirements.
 - 2. Construction Hazard Plan.

1.02 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
 - 1. OSHA 1926 R.E.G. - 29 CFR, OSHA, 1926.

1.03 SUBMITTALS

- A. Submittals for PAANG Approval: The following items shall be submitted for PAANG approval:
 - 1. Designation of Safety Representative: The Contractor shall designate in writing a qualified employee OSHA Trained under 29CFR1926 responsible for the overall supervision of all accident prevention activities. Duties shall include ensuring applicable safety requirements are incorporated into work methods and inspecting the jobsite to ensure that safety measures and instructions are actually being applied. This person shall be on site at all time that work is in progress.
 - 2. The Contractor shall be trained/certified in 29CFR1926 procedures. All other employees performing site work will meet 29CFR1926 training requirements for their job capacity.
- B. Submittals for Information Only: The following items shall be Contractor certified:
 - 1. Job Hazard Analysis: Contractor shall develop a job hazard analysis for presentation at the preconstruction conference. The Contractor's job hazard analysis shall list potential hazards that could arise during the course of the work.
 - 2. Job Safety and Health Plan:
 - a. The Contractor shall develop a Job Safety and Health Plan for presentation at the Pre-construction conference. The Contractor's Safety Plan shall make whatever provisions are necessary to conduct his work in accordance with current OSHA standards.
 - b. The following are minimum requirements for the health and safety plan:
 - 1) Safety Plans: Safety Plans will be the responsibility of the Contractor for construction areas identified by the installation and/or PAANG as areas of known hazards only. These plans are required by 29CFR1926 and are the responsibility of the Contractor. This requirement will be coordinated through the Health and Safety Program of the military installation by the Contractor.
 - 2) Minimum Requirements for the Health and Safety Plan are as follows:
 - (a) Must be kept on site, and must be written.
 - (b) Will contain a hazard analysis (safety and health risk) for each site task and operation (to be supplied by the installation).
 - (c) Will include employee training.
 - (d) Will include personal protective equipment to be used by employees for each of the site tasks and operations.
 - (e) Will include provision for medical surveillance.
 - (f) Will include the frequency and types of air monitoring, personal monitoring, environmental sampling techniques, instruments to be used (their maintenance and calibration).
 - (g) Will include a site control program to be coordinated with the installation.
 - (h) Will include a decontamination procedure.
 - (i) Will include an emergency response plan.

- (j) Will include a confined space entry procedure.
 - (k) Will include provision for spill containment.
 - (l) Will include pre-entry briefings for confined space entry (prior to each site task activity) for all employees involved in the task, supervision, or emergency response.
 - (m) Will include telephone notification of accidents and followed by a written report of the accident.
 - (n) Written verification of adherence to the "plan" by a Safety and Health Supervisor is required (the supervisor must meet the 29CFR1926 training requirements for supervisors).
 - (o) Deficiencies will be corrected immediately upon discovery and after consultation with the PAANG Contracting Officer or Designated Representative.
- 3) Hazard Response Plan: The unplanned or non-predicted discovery of such hazards as transite pipe, contaminated soils, and other possible hazards must be addressed within an Emergency Response Plan (EMR) by all Contractors. This requirement will be coordinated through the Health and Safety Program of the military installation by the Contractor (sample provided by Contracting Officer or Designated Representative).
- (a) Material Safety Data Sheets must be maintained at the site for all hazardous materials in use.

1.04 MONTHLY SAFETY MEETINGS

- A. The installation will schedule subsequent safety meetings with Contractor and Subcontractor personnel on a monthly basis. Minutes of safety meetings shall be prepared and signed by the Contractor. Concurrence signed by Inspection Section and the original submitted to the Contracting Officer or Designated Representative's for inclusion in the contract file.

1.05 LIFE OF CONTRACT REQUIREMENTS

- A. The Contractor shall comply with 29CFR1926 and all provisions of this section during the life of the contract.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 HEAD PROTECTION (HARD HATS)

- A. All work sites under this contract are designated Hard Hat Areas. The Contractor shall post the area and shall ensure that all personnel, vendors and visitors use hard hats while within the limits of the work site.

END OF SECTION

**SECTION 01 10 00
SUMMARY****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
 - 1. Project information.
 - 2. Work covered by Contract Documents.
 - 3. Work under Owner's separate contracts.
 - 4. Future work not part of this Project.
 - 5. Contractor's use of site and premises.
 - 6. Work restrictions.
 - 7. Specification and Drawing conventions.

1.02 PROJECT INFORMATION

- A. Project Name: SOF Construct Simulator Facility MC-130J.
- B. Project Location: Pennsylvania Air National Guard Base, at the Harrisburg International Airport, Middletown, PA.
- C. Owner: Pennsylvania Air National Guard.
 - 1. Government's Representative: TBD
- D. Coordinating Contractor for multiple Contracts: The General Trades Contractor shall serve as the lead Prime Contractor as the Coordinating Contractor.

1.03 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work is defined by the Contract Documents and consists of the following but not limited to:
 - 1. Site development of an existing parking lot approximately one acre in size including extension of water, natural gas, stormwater, sanitary sewer, communication and off site electric utilities. Building construction consists of a two story 17,000 square foot administration and simulator building.
- B. Type of Contract:
 - 1. Project will be constructed under multiple-Prime Contracts. Contracts for this Project include the following:
 - a. Contract 01 GTC - General Trades Construction
 - b. Contract 02 HVAC – HVAC Construction
 - c. Contract 03 PC – Plumbing Construction
 - d. Contract 04 EC – Electrical Construction
 - e. See Section 01 12 00 - Multiple Contract Summary for a description of work included under each of the multiple contracts and the responsibilities of the Project Coordinator.

1.04 WORK UNDER OWNER'S SEPARATE CONTRACTS

- A. The Government will engage a contractor to relocate the aircraft simulator and associated equipment as well as the VESDA fire detection system.

1.05 FUTURE WORK NOT PART OF THIS PROJECT

- A. Not Applicable.

1.06 CONTRACTOR'S USE OF SITE AND PREMISES

- A. General: Each Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.
- B. There will be limited onsite parking for contractor employees. Any offsite parking needs shall be the responsibility of the Contractor(s).

- C. Use of Site: Limit use of Project site to Work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
 - 1. Limits: Confine construction operations to areas shown on drawings.
 - 2. Driveways, Walkways and Entrances: Keep driveways, parking, loading areas, and entrances serving premises clear and available to the Government, Government equipment, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.
 - a. Schedule deliveries to minimize use of on-base roads by construction operations.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- D. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

1.07 COORDINATION WITH OCCUPANTS

- A. The Government intends to continue operations in adjacent buildings and facilities. Ensure construction operations do not hinder the movement of personnel and equipment without prior notification and coordination with the Government.

1.08 WORK RESTRICTIONS

- A. Comply with restrictions on construction operations.
 - 1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work to between 7 a.m. to 4 p.m., exclusive of Saturdays, Sundays and Federal Holidays, unless otherwise indicated. Work hours may be modified to meet Project requirements if approved by the Government and authorities having jurisdiction.
 - 1. Weekend Hours: Are available upon request and justification.
 - 2. Early Morning and Late Evening Hours: Are available upon request and justification, and as allowed as per the availability of security forces and the requirements of the authority having jurisdiction.
 - 3. Hours for Utility Shutdowns: Coordinate with the Government.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Government unless permitted under the following conditions and then only after arranging for temporary utility services according to requirements indicated:
 - 1. Notify Government not less than ten (10) business days in advance of proposed utility interruptions.
 - 2. Obtain the Contracting Officer's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, Dust, and Odors: Coordinate operations that may result in high levels of noise and vibration, dust, odors, or other disruption to Government occupancy with Government.
 - 1. Notify Contracting Officer not less than two (2) business days in advance of proposed disruptive operations.
 - 2. Obtain Contracting Officer's written permission before proceeding with disruptive operations.
- E. Smoking and Controlled Substance Restrictions: Use of tobacco products, vaping and other controlled substances on Project site is prohibited.

1.09 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

2. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; no emphasis is implied by text with these characteristics.
 3. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is not residing in the Specifications. Unless otherwise indicated, linked information is not part of the Contract Documents.
 4. Specification requirements are to be performed by the Contractor unless specifically stated otherwise.
 5. The DRAWINGS and SPECIFICATIONS are one part of the Contract Documents set and shall be used in conjunction with the remaining parts of the Contract Documents. "DRAWINGS" means the latest design drawings and "SPECIFICATIONS" means the latest project specifications. In cases where requirements indicated on the DRAWINGS differ from the SPECIFICATIONS, the Contractor shall notify the Government and assume the most stringent requirement until otherwise notified in writing by the Contracting Officer. Additionally, where referenced codes and standards identified in the plans, notes, or specifications conflict the more stringent or conservative provisions shall control. The Contractor shall notify the Government of any such conflicts discovered.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products.
1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.

PART 2 - PRODUCTS (NOT USED)**PART 3 - EXECUTION (NOT USED)****END OF SECTION**

**SECTION 01 12 00
MULTIPLE CONTRACT SUMMARY**

PART 1 GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section. The requirements of this Section apply to all Contractors unless otherwise noted.

1.02 SUMMARY

- A. Section includes a summary of each Contract, including responsibilities for coordination and temporary facilities and controls.
 - 1. Coordinating Contractor
 - 2. Multiple Prime Contracts:
 - a. Contract 01 GTC – General Trades Construction
 - b. Contract 02 HVAC – HVAC Construction
 - c. Contract 03 PC – Plumbing Construction
 - d. Contract 04 EC – Electrical Construction
- B. Unless the Agreement contains a more specific description of the Work of each Contract, requirements indicated on the Drawings and in Specifications Sections determine which Contract includes a specific element of the Project.

1.03 DEFINITIONS

- A. Verify: The term “verify” means “to measure, investigate, review, test, check the accuracy or correctness of and prove by demonstration, evidence, or testimony the location, size, dimension, and condition of an item.”
- B. Furnish: The term “furnish” means “to supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations.”
- C. Install: The term “install” is used to describe operations at the Project site including the actual “unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, performing, coordinating, protecting, cleaning and similar activities.”
- D. Provide: The term “provide” means “to furnish and install, complete, and ready for the intended use.”

1.04 COORDINATING CONTRACTOR

- A. The General Trades Contractor (GTC) shall act as the Coordinating Contractor and shall be responsible for coordination between all Prime Contractors, the Government, and any authorities having jurisdiction.

1.05 COORDINATING CONTRACTOR RESPONSIBILITIES

- A. The Coordinating Contractor shall perform Project coordination activities for the multiple Contracts, including, but not limited to, the following:
 - 1. Provide typical overall coordination of the Work.
- B. Provide an overall Project Schedule with input and coordination from all Contractors.
 - 1. Coordinate shared access to workspaces.
 - 2. Coordinate product selections for compatibility between Work of each Prime Contractor.
 - 3. Provide overall coordination of temporary facilities and controls.
 - 4. Coordinate, schedule, and approve interruptions of permanent and temporary utilities, including but not limited to those necessary to make connections for temporary services.
 - 5. Coordinate construction and operations of the Work with work performed by each Contractor.
 - 6. Coordinate sequencing and scheduling of the Work.
 - 7. Coordinate quality-assurance and quality-control services specified in Section 01 40 00 "Quality Requirements."

8. Coordinate sequence of activities to accommodate tests and inspections, and coordinate schedule of tests and inspections specified in 014523" Testing and Inspection Services."
9. Coordinate the Work necessary to adjust, move, or relocate existing utility structures affected by construction.
10. Locate existing permanent benchmarks, control points, and similar reference points, and establish permanent benchmarks on Project site.
11. Provide field surveys of in-progress construction and site work and final property survey.
12. Provide progress cleaning of common areas and coordinate progress cleaning of areas or pieces of equipment where more than one Contractor has worked.
13. Coordinate cutting and patching.
14. Coordinate protection of the Work.
15. Coordinate firestopping.
16. Coordinate completion of interrelated punch list items.
17. Coordinate preparation of Project Record Documents to be integrated with information from other Contractors to form one combined record.
18. Print and submit Record Documents if installations by more than one Contractor are indicated on the same Contract Drawing or Shop Drawing.
19. Collect record Specification Sections from Contractors, collate Sections into numeric order, and submit complete set.
20. Coordinate preparation of operation and maintenance manuals to be integrated with information from other Contractors to form one combined record.

1.06 GENERAL REQUIREMENTS OF ALL CONTRACTS

- A. Each Contractor shall at all times observe and comply with all Federal, State and Local laws and regulations, bylaws, ordinances, and regulations in any manner affecting the conduct of the Work or applying to employees on the Project, as well as all safety precautions and orders or decrees which have been promulgated or enacted, or which may be promulgated or enacted, by legal bodies or tribunals having authority or jurisdiction over the work, materials, equipment or employees. Such observance and compliance shall be solely and without qualification the responsibility of the Prime Contractors without reliance on the Project Superintendent or direction by the Government or their Representatives. The duty of enforcement of all said laws, ordinances, regulations, orders, or decrees lies with the body of agency promulgating them, not with the Government or their Representatives.
- B. Each Contractor shall provide safety and protection of persons and property per OSHA, Local and State and Government requirements, and shall provide all safety signage required by OSHA specific to their Work. Each Prime Contractor shall furnish the Government with a "project-specific" Health and Safety Plan (HASP) prior to start of work and shall maintain site conduct in accordance with the rules and procedures specified in the General Conditions.
- C. Each Contractor shall be responsible for thoroughly reviewing the entire set of Contract Documents, including but not limited to all Drawings and all Specifications, Special Provisions and Appendices for incorporation into their Scope of Work/Contract. Each Prime Contractor shall coordinate their work with the work of all other Prime Contractors.
- D. If the Contractor proposes materials, products or equipment other than those listed or indicated as the basis of design, then the Contractor shall comply with provisions pertaining to substitutions specified in 01 25 00 - Substitution Procedures to obtain the Government's acceptance of such materials, products or equipment, whether or not it is included in a listing of acceptable manufacturers. When an accepted substitute, or equivalent to item of equipment or material, requires changes or additions to the Project, the Contractor shall make the adjustments and changes required to coordinate the Work for installation, without any additional cost to the Government.
- E. Each Contractor shall coordinate and provide required information to the Coordinating Contractor for development and maintenance of the CPM Project Construction Schedule for the Project as per Specification Section 01 32 00 - Construction Progress Documentation.

- F. Each Contractor shall provide survey, engineering, and layout required to perform the Work of their Contract.
- G. Each Contractor shall provide bracing and shoring as necessary to protect existing utilities from damage from their Work.
- H. Each Contractor shall provide shoring, hoists, ladders, scaffolding, barricades, ramps, etc. necessary for the Work of their Contract.
- I. Each Contractor is responsible to keep site debris off the local roads, provide dust, noise control, provide daily clean-up, and trash removal resulting from the Work or employees of their Contract.
- J. The Government shall provide all Special Inspections and Testing as per the IBC 2018, Section 17. Any other inspection or testing shall be the responsibility of the Prime Contractor requiring the work. This is further defined in Section 014523 "Testing and Inspection Services" and/or individual Technical Specification sections.
- K. Unless otherwise indicated, the Work described in this Section for each Contract shall be complete systems and assemblies, including products, components, accessories, and installation required by the Contract Documents and per industry standards.

1.07 SPECIFIC SCOPE REQUIREMENTS OF EACH CONTRACT

- A. Extent of Contract: Unless the Agreement contains a more specific description of the Work of each Contract, requirements indicated on Drawings and in Specification Sections determine which Contract includes a specific element of the Project. The items noted below are intended to provide additional clarification of division of scope between the Contractor and are not inclusive of all scope requirements. Contractors are responsible for review of all Contract Documents including the Responsibility Matrix to identify Work required under their Contract.
- B. Each Contractor shall provide anchor bolts, blocking, backing panels, sleeves, and metal fabrication supports for their Work.
- C. Unless identified on the Structural Drawings, each Contractor shall provide lintels needed for their Work.
- D. Each Contractor shall furnish access panels for their Work. Installation of access panels in gypsum board partitions shall be the Work of the General Trades Contractor. Installation of access panels in non-gypsum board partitions shall be by the Contractor furnishing the access panels.

1.08 EACH CONTRACTOR SHALL FURNISH ROOF MOUNTED EQUIPMENT CURBS FOR THEIR WORK FOR THE INSTALLATION BY THE GENERAL TRADES CONTRACTOR. THE GENERAL TRADES CONTRACTOR SHALL PROVIDE BLOCKING AND OR REINFORCEMENT NECESSARY FOR THE ROOF PENETRATIONS OF ALL CONTRACTS.

- A. Each Contractor shall provide touch-up painting as required for their Work.
- B. Each Contractor shall provide cutting and patching as required for their Work.
- C. Each Contractor shall provide through-penetration firestopping for their Work.
- D. Each Contractor shall provide all necessary caulking for their Work.
- E. Final MEP connections shall be performed by the Contractor providing the utility.
- F. The General Trades Contractor shall purchase and maintain property insurance for the Work to the full insurable value thereof. This insurance shall be in an amount sufficient to protect the interests of the Government, General Trades Contractor, other Contractors, subcontractors, Government and Government's consultants in the Work, all of whom shall be listed as insured or additional insured parties. The insurance shall: be written on a Builder's Risk all-risk or open peril or special causes of loss policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, falsework and Work in transit and shall insure against at least the following perils or causes of loss: fire, lightning, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned

by enforcement of laws and regulations, water damage, and such other perils or causes of loss as may be specifically required by the Supplemental Conditions; include expenses incurred in the repair or replacement of any insured property (including, but not limited to, fees and charges of the Government); and cover materials and equipment stored at the site or at another location that was agreed to in writing by Government prior to being incorporated in the Work, provided that such materials and equipment have been included in an application for payment recommended by the Government. The Contractor shall also purchase and maintain coverage against losses, damages and expenses arising out of or resulting from any insured loss or incurred in the repair or replacement of any insured property.

- G. The General Trades Contractor will provide all Site demolition.
- H. All permits, fees, Federal, State, and Local Taxes, material testing and inspection services, insurances, etc. required to perform the work of their Contract are the responsibility of the appropriate Contractor(s).
- I. Any temporary or permanent utility connection fees shall be the responsibility of the Contractor requiring the Work.
- J. The General Trades Contractor shall provide all interior and exterior concrete equipment and housekeeping pads, including mechanical pads noted in the Contract Documents. All Contractors shall coordinate specific pad requirements with the General Trades Contractor. Any required conduits, sleeves or imbeds shall be provided by Contractor requiring the Work.
- K. The General Trades Contractor shall be responsible for all trenching and excavation for all primary, secondary and any ancillary system requirements for all storm, sewer, electrical, water and gas piping systems to within 5' of building(s). Dewatering, setting bed, backfill, compaction, concrete ductbank, conduit, piping, warning tape, etc. for these systems shall be provided by Contractor responsible for the specific utility or system. Trenching, excavation, dewatering, setting bed, backfill, compaction, concrete ductbank, conduit, piping, warning tape, etc. for these systems from 5' outside and within the building footprint shall be provided by Contractor responsible for that system.
- L. The General Trades Contractor shall provide excavation for all site light bases. The Electrical Contractor shall provide bases, backfill and compaction.
- M. The General Trades Contractor shall be the O&M/Warranty Coordinator for this project. Reference Specification Section 013100 - Project Management and Coordination.
- N. The Plumbing Contractor will be responsible for the sprinkler system/delegated design and any associated permits and review fees, and inspection code fees associated with this Work.
- O. The HVAC Contractor shall lead the MEP Coordination Drawings effort and prepare mechanical, electrical, and plumbing coordination drawings. The HVAC Contractor shall prepare 1/4" scale CAD drawings with ductwork and piping layout for review by the other Contractors. The other Contractors shall then prepare and provide CAD additions/modifications representing their Work to the HVAC Contractor, who will then prepare final layout and coordination drawings illustrating Work by all Contractors on one set of coordination drawings for the Project as a part of their Contract price. The HVAC Contractor shall conduct coordination meetings with all Contractors to discuss and resolve conflicts. Once each Contractor has initialed with approval the coordination drawings, the HVAC Contractor shall submit the coordination drawings as a Submittal for review. The other Contractors should finalize their shop drawings in accordance with the approved coordination drawings and submit as part of the Submittal process.
- P. The Electrical Contractor will be responsible for the fire alarm system / delegated design and any associated permits and review fees, and inspection code fees associated with this work.
- Q. Electrical contractor to provide primary electrical power to equipment provided under the General Trades, Plumbing and HVAC Contracts.

1.09 PRIME CONTRACTOR RESPONSIBILITY MATRIX

- A. The attached Prime Contractor Responsibility Matrix is being provided as a guide for all Contractors and not meant to be all inclusive. Any work within a Section that is required but not specifically noted on the attached as the responsibility of a specific Contractor, but still required, and customarily the Work of that Contractor shall be included in that Contractor's Work.
- B. PRIME CONTRACT RESPONSIBILITY MATRIX KEY
 - 1. P = PRIMARY RESPONSIBILITY:
 - a. This Prime Contractor is responsible for the provision of Labor, Material, Equipment and Quality Control to furnish and install this Work.
 - 2. E = EACH PRIME CONTRACTOR:
 - a. Each Prime Contractor is responsible for this section as it applies to their Scope of Work.
 - 3. S = SECONDARY RESPONSIBILITY:
 - a. The Secondary Contractor is responsible to coordinate and provide any of their required items (imbeds, sleeves, conduits, flashings, and the like) to the Primary Contractor for inclusion in that Primary Contractor's work to ensure a complete system.
 - 4. FINAL CONNECTIONS:
 - a. Final connections shall be made by Primary Contractor responsible for the utility

END OF SECTION

PRIME CONTRACT RESPONSIBILITY MATRIX					
SPECIFICATIONS		PRIME CONTRACTORS			
SECTION	TITLE	(1) GTC	(2) HVAC	(3) PC	(4) EC
DIVISION 01	PROCUREMENT AND CONTRACTING REQUIREMENTS	E	E	E	E
DIVISION 02	EXISTING CONDITIONS				
02 41 00	SELECTIVE DEMOLITION	P			
DIVISION 03	CONCRETE				
03 10 00	CONCRETE FORMWORK	P	S	S	S
03 11 19	INSULATING CONCRETE FORMWORK	P		S	S
03 20 00	CONCRETE REINFORCEMENT	P	S	S	S
03 30 00	CAST IN PLACE CONCRETE	P			
03 60 00	GROUT	P			
DIVISION 04	MASONRY				
04 20 00	UNIT MASONRY	P			
DIVISION 05	METALS				
05 12 00	STRUCTURAL STEEL	P			
05 21 00	STEEL JOIST FRAMING	P			
05 31 00	STEEL DECKING	P			
05 44 00	PRE-ENGINEERED, PREFABRICATED LIGHT GAUGE STEEL ROOF TRUSSES	P			
05 50 00	METAL FABRICATIONS	P			
05 51 00	METAL STAIRS	P			
05 51 33	METAL LADDERS	P			
DIVISION 06	WOOD AND PLASTIC, AND COMPOSITES				
06 10 00	Rough Carpentry	P			
DIVISION 07	THERMAL AND MOISTURE PROTECTION				
07 14 00	FLUID-APPLIED WATERPROOFING	P			
07 21 00	THERMAL INSULATION	P			
07 41 13	METAL ROOF PANELS	P			
07 42 13	METAL WALL PANELS	P	S	S	S
07 42 13.19	INSULATED METAL WALL PANELS	P			
07 42 13.23	METAL COMPOSITE MATERIAL WALL PANELS	P			
07 46 46	FIBER CEMENT SIDING	P			
07 54 00	THERMOPLASTIC MEMBRANE ROOFING	P	S	S	S
07 62 00	SHEET METAL FLASHING AND TRIM	P	S	S	S
07 72 00	ROOF ACCESSORIES	P	S	S	S
07 84 00	FIRESTOPPING	E	E	E	E
07 92 00	JOINT SEALANTS	E	E	E	E
DIVISION 08	OPENINGS				
08 11 13	HOLLOW METAL DOORS AND FRAMES	P			S
08 14 16	FLUSH WOOD DOORS	P			S
08 36 13	SECTIONAL OVERHEAD DOORS	P			
08 43 13	ALUMINUM-FRAMED STOREFRONTS	P			S
08 71 00	DOOR HARDWARE	P			S
08 80 00	GLAZING	P			
08 91 00	LOUVERS	P	S	S	S
DIVISION 09	FINISHES				
09 21 16	GYPSUM BOARD ASSEMBLIES	P			
03 67 99	TILING	P			
09 51 00	ACOUSTICAL CEILINGS	P	S	S	S
09 65 19	RESILIENT TILE FLOORING	P			
09 91 23	INTERIOR PAINTING	P			
DIVISION 10	SPECIALTIES				
10 14 00	SIGNAGE	P			
10 21 13.13	METAL TOILET COMPARTMENTS	P			
10 22 39	FOLDING PANEL PARTITIONS	P			
10 28 00	TOILET, BATH, AND LAUNDRY ACCESSORIES	P			

10 44 00	FIRE PROTECTION SPECIALTIES	P			
DIVISION 11	EQUIPMENT				
11 05 00	COMMON WORK RESULTS FOR SHOP EQUIPMENT	P			S
11 52 23	TELEVISION MOUNTS	P			S
DIVISION 12	FURNISHING				
12 32 00	MANUFACTURED WOOD CASEWORK	P		S	
12 36 00	COUNTERTOPS	P		S	
12 48 13	ENTRANCE FLOOR MATS AND FRAMES	P			
DIVISION 13	SPECIAL CONSTRUCTION				
13 46 13	LIGHTNING PROTECTION FOR STRUCTURES	S			P
DIVISION 14	CONVEYING EQUIPMENT				
14 21 00	ELECTRIC TRACTION ELEVATOR	P	S	S	S
DIVISION 21	FIRE SUPPRESSION				
21 05 00	COMMON WORK RESULTS FOR FIRE SUPPRESSION			P	S
21 05 23	GENERAL-DUTY VALVES FOR WATER-BASED FIRE SUPPRESSION PIPING			P	
21 05 29	HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPING AND EQUIPMENT			P	
21 05 48	VIBRATION AND SEISMIC CONTROLS FOR FIRE SUPPRESSION PIPING AND EQUIPMENT			P	
21 05 53	IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT			P	
21 08 00	COMMISSIONING OF FIRE SUPPRESSION		S	P	S
21 11 19	FIRE DEPARTMENT CONNECTIONS			P	S
21 13 13	WET-PIPE SPRINKLER SYSTEMS			P	S
DIVISION 22	PLUMBING				
22 05 17	SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING			P	
22 05 19	METERS AND GAUGES FOR PLUMBING PIPING			P	S
22 05 23	GENERAL-DUTY VALVES FOR PLUMBING PIPING			P	
22 05 29	HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT			P	
22 05 53	IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT			P	
22 07 19	PLUMBING PIPING INSULATION			P	
22 10 05	PLUMBING PIPING			P	
22 10 06	PLUMBING PIPING SPECIALTIES			P	
22 30 00	PLUMBING EQUIPMENT			P	S
22 40 00	PLUMBING FIXTURES	S		P	S
DIVISION 23	HEATING, VENTILATING AND AIR CONDITIONING (HVAC)				
23 05 13	COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT		P		S
23 05 17	SLEEVES AND SLEEVE SEALS FOR HVAC PIPING		P		
23 05 29	HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT		P		
23 05 53	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT		P		
23 05 93	TESTING, ADJUSTING, AND BALANCING FOR HVAC		P		
23 07 13	DUCT INSULATION		P		
23 07 19	HVAC PIPING INSULATION		P		
23 08 00	COMMISSIONING OF HVAC		P		
23 09 13	INSTRUMENTATION AND CONTROL DEVICES FOR HVAC		P		S
23 09 23	DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC		P		S
23 11 23	FACILITY NATURAL-GAS PIPING		P		
23 21 13	HYDRONIC PIPING		P		S
23 22 13	STEAM AND STEAM CONDENSATE PIPING		P		
23 23 00	REFRIGERANT PIPING		P		
23 31 00	HVAC DUCTS AND CASINGS		P		
23 33 00	AIR DUCT ACCESSORIES		P		
23 34 23	HVAC POWER VENTILATORS		P		S
23 37 00	AIR OUTLETS AND INLETS		P		
23 74 33	DEDICATED OUTDOOR AIR UNITS		P	S	S
23 81 26.13	SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS		P	S	S
23 81 29	VARIABLE REFRIGERANT FLOW HVAC SYSTEMS		P	S	S
23 82 00	CONVECTION HEATING UNITS		P	S	S

23 84 15	STEAM HUMIDIFIERS		P	S	
DIVISION 25	INTEGRATED AUTOMATION				
25 05 11	CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS		S		P
DIVISION 26	ELECTRICAL				
26 05 05	SELECTIVE DEMOLITION FOR ELECTRICAL				P
26 05 13	MEDIUM-VOLTAGE CABLES				P
26 05 19	LOW-VOLTAGE WIRE, CABLE, AND ACCESSORIES				P
26 05 26	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS				P
26 05 29	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS				P
26 05 33.13	CONDUIT FOR ELECTRICAL SYSTEMS				P
26 05 33.16	BOXES FOR ELECTRICAL SYSTEMS				P
26 05 53	IDENTIFICATION FOR ELECTRICAL SYSTEMS				P
26 05 73	POWER SYSTEM STUDIES				P
26 05 83	WIRING CONNECTIONS				P
26 09 23	LIGHTING CONTROL DEVICES				P
26 12 00	MEDIUM-VOLTAGE TRANSFORMERS				P
26 22 00	LOW-VOLTAGE TRANSFORMERS				P
26 24 16	PANELBOARDS				P
26 27 13	ELECTRICITY METERING				P
26 27 26	WIRING DEVICES				P
23 28 16.13	ENCLOSED CIRCUIT BREAKERS				P
26 28 16.16	ENCLOSED SWITCHES				P
26 43 00	SURGE PROTECTIVE DEVICES				P
26 51 00	INTERIOR LIGHTING	S			P
26 56 00	EXTERIOR LIGHTING	S			P
DIVISION 27	COMMUNICATIONS				
27 05 29	HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS				P
27 05 33.13	CONDUIT FOR COMMUNICATIONS SYSTEMS				P
27 05 36	CABLE TRAYS FOR COMMUNICATIONS SYSTEMS				P
27 10 00	STRUCTURED CABLING				P
DIVISION 28	ELECTRONIC SAFETY AND SECURITY				
28 46 00	FIRE DETECTION AND ALARMS		S		P
DIVISION 31	EARTHWORK				
31 22 00	GRADING	P			
31 23 16	EXCAVATION	P			
31 23 16.13	TRENCHING	E	E	E	E
31 23 23	FILL	P			
31 62 16.16	STEEL H PILES	P			
DIVISION 32	EXTERIOR IMPROVEMENTS				
32 11 20	SUBBASE AND AGGREGATE BASE COURSES	P			
32 12 16	ASPHALT PAVING	P			
32 13 13	CONCRETE PAVING	P			
32 16 23	SIDEWALKS	P			
32 17 23	PAVEMENT MARKINGS	P			
32 17 26	TACTILE WARNING SURFACES	P			
32 33 00	SITE FURNISHINGS	P			
32 92 19	SEEDING	P			
DIVISION 33	UTILITIES				
33 01 10.58	DISINFECTION OF WATER UTILITY PIPING SYSTEMS	P		S	
33 05 61	CONCRETE MANHOLES	P			
33 14 16	SITE WATER UTILITY DISTRIBUTION PIPING	P		S	
33 31 13	SITE SANITARY SEWERAGE GRAVITY PIPING	P			
33 42 11	STORMWATER GRAVITY PIPING	P			
33 52 16	GAS HYDROCARBON PIPING	P		S	
33 71 19	ELECTRICAL UNDERGROUND DUCTS, DUCTBANKS, AND MANHOLES	S			P
DIVISION 41	MATERIAL HANDLING AND PROCESSING				
41 22 13.13	BRIDGE CRANE	P			S

**SECTION 01 25 00
SUBSTITUTION PROCEDURES**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section. The requirements of this Section apply to all Contractors unless otherwise noted.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Section 01 60 00 - Product Requirements for requirements for submitting comparable product submittals for products by listed manufacturers.

1.03 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
 - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - 2. Substitutions for Convenience: Changes proposed by Contractor or Government that are not required in order to meet other Project requirements but may offer advantage to Contractor or Government.

1.04 ACTION SUBMITTALS

- A. Substitution Requests: Submit one electronic copy of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use Contractor's standard form.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
 - b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Others,
 - 1) Contractors and Separate Contractors that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of Designers and the Government.
 - h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
 - i. Research reports evidencing compliance with building code in effect for the Project.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall

Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.

- k. Cost information, including a proposal of change, if any, in the Contract Sum.
 - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Designer's Action: If necessary, Designer will request additional information or documentation for evaluation within five (5) business days of receipt of a request for substitution. Government will notify Contractor of acceptance or rejection of proposed substitution within fifteen (15) business days of receipt of request, or seven (7) business days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Government's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Government does not issue a decision on use of a proposed substitution within time allocated.

1.05 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.06 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

1.07 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than fifteen (15) business days prior to time required for preparation and review of related submittals.
 - 1. Conditions: Government will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Government will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Substitution request is fully documented and properly submitted.
 - c. Requested substitution will not adversely affect Contractor's construction schedule.
 - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - e. Requested substitution is compatible with other portions of the Work.
 - f. Requested substitution has been coordinated with other portions of the Work.
 - g. Requested substitution provides specified warranty.
 - h. If requested substitution involves more than one Contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all Prime and Separate Contractors involved.
- B. Contractor may not substitute materials or products deemed "Buy America Act" with materials or products not in compliance with the before mentioned Act.
- C. Substitutions for Convenience: Government will consider requests for substitution if received within sixty (60) days after the Notice to Proceed. Requests received after that time may be

considered or rejected at discretion of Government within a minimum of fifteen (15) business days.

1. Conditions: Government will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied,
 - a. Government will return requests without action, except to record noncompliance with these requirements:
 - b. Requested substitution offers Government a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Government must assume. Government's additional responsibilities may include compensation to Government for redesign and evaluation services, increased cost of other construction by Government, and similar considerations.
 - c. Requested substitution does not require extensive revisions to the Contract Documents.
 - d. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - e. Substitution request is fully documented and properly submitted.
 - f. Requested substitution will not adversely affect Contractor's construction schedule.
 - g. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - h. Requested substitution is compatible with other portions of the Work.
 - i. Requested substitution has been coordinated with other portions of the Work.
 - j. Requested substitution provides specified warranty.
 - k. If requested substitution involves more than one Contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all Prime and Separate Contractors involved.

END OF SECTION

SECTION 01 31 00
PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL**1.01 SUMMARY**

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. Request for Information (RFIs).
 - 4. Digital project management procedures
 - 5. Project meetings.
 - 6. Field Manpower Reports
- B. Related Requirements:
 - 1. Section 011200 - Multiple Contract Summary and the related Responsibility Matrix for a description of the division of work among Contracts and responsibility for coordination activities not in this Section.
 - 2. Section 017300 - Execution for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 3. Section 017700 - Closeout Procedures for coordinating closeout of the Contract.

1.02 DEFINITIONS

- A. RFI: Request from Government or Contractor seeking information required by or clarification of the Contract Documents.
- B. Coordinating Contractor: The General Trades Contractor shall be the Coordinating Contractor for the Project. The Coordinating Contractor is ultimately responsible for all coordination between the General Trades, Plumbing, HVAC and Electrical Prime Contractors.
- C. Coordination Drawings: The HVAC Contractor shall be responsible for the Project's coordination drawings. This includes the development and distribution thereof, as well as the facilitation of meetings with the various Prime Contractors and other trades to ensure the Plumbing, HVAC and Electrical Trades Systems are coordinated to installation into the Project. This is further enumerated in the Common Work Results of Division 23 for the HVAC Contractor.
- D. O&M/Warranty (Operation and Maintenance) Manual Coordinator: The General Trades Contractor shall be responsible to compile all Operation and Maintenance Manuals as well as Warranties into one file/folder for turnover to the Government at the close of the Project. The combined O&M/Warranty manual shall be sorted by CSI specification section and contain a table of contents. As an appendix to the combined O&M/Warranty manual there shall be a matrix/spreadsheet identifying all of the equipment provided on the Project that requires routine maintenance by the Government's facility staff upon turnover of the Project. This matrix/spreadsheet shall list equipment, equipment serial numbers, replacement parts and filters and shall identify, from each manufacturer's operation and maintenance manual(s) the frequency of service. Additionally, all Warranties (Material, Equipment, Labor, etc.) shall be listed and the duration from the date of Substantial Completion that the Warranty is good for. This combined O&M/Warranty Manual shall be submitted to the Government for review and comment prior to acceptance. This shall be listed as a line item on the General Trades Contractor's schedule of values and will be a requirement of Final Payment for the General Trades Contractor.

1.03 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
- B. Key Personnel Names: Within fourteen (14) calendar days of start of Construction, Contractor shall submit a list of key personnel assignments, including superintendent and other personnel in attendance at the Project site. Identify individuals and their duties and responsibilities; office and cellular telephone numbers; and e-mail addresses. Provide names and contact information for individuals assigned as alternates in the absence of individuals assigned to the Project.
 1. Post copies of the list in the Contract and Government field offices. Keep the list current at all times.

1.04 GENERAL COORDINATION PROCEDURES

- A. Each Contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific Contractor. The General Trades Contractor will be the Coordinating Contractor for the other Prime Contractors.
- B. Coordination: Each Contractor shall coordinate its construction operations with those of other Contractors and entities to ensure efficient and orderly installation of each part of the Work. Each Contractor shall coordinate its operations with operations included in different Sections that depend on other Contractors for proper installation, connection, and operation.
 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
 4. Where a Contractor selected system or equipment differs from the basis of design, the Contractor responsible for the subject system and equipment is to coordinate with all other Contractors regarding work, materials, systems, etc. that may be impacted or require adjustment to properly install the selected system or equipment.
- C. Each Contractor shall prepare memoranda for distribution for each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and a list of attendees at meetings.
 1. Prepare similar memoranda for the Government and separate Contractors if coordination of their Work is required.
- D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 1. Preparation of Contractor's construction schedule.
 2. Preparation of the schedule of values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Utility shutdowns.
 7. Hot work permits.
 8. Laydown areas
 9. Delivery of any material or equipment which may impact other trades accessing the Work.
 10. Preinstallation conferences.
 11. Project closeout activities.
 12. Startup and adjustment of systems.
- E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into the Work. See other Sections for disposition of salvaged materials that are designated as the Government's property.

1.05 COORDINATION DRAWINGS

- A. Coordination Drawings, General: The HVAC Contractor shall lead the coordination drawing effort for the Plumbing, Mechanical and Electrical Work. The HVAC Contractor shall prepare 1/4" scale CAD drawings with ductwork and piping layout for review by the other Prime Contractors. The other Prime Contractors shall then prepare and provide CAD additions/modifications representing their Work to the HVAC Contractor, who will then prepare final layout and coordination drawings illustrating Work by all Prime Contractors on one set of coordination drawings for the Project as a part of their Contract price. The HVAC Contractor shall conduct coordination meetings with all Prime Contractors to discuss and resolve interference problems. Once each Prime Contractor has initialed with approval the coordination drawings, the HVAC Contractor shall submit the coordination drawings to the Government as a Submittal for review. The other Prime Contractors should finalize their shop drawings in accordance with the approved coordination drawings and submit to the Government as part of the Submittal process.

1.06 REQUEST FOR INFORMATION (RFI).

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 1. Government will return without response those RFIs submitted to the Government by other entities controlled by Contractor.
 2. Contractors shall coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
 1. Government name.
 2. GoveProject number.
 3. Date.
 4. Name of Contractor.
 5. RFI number, numbered sequentially.
 6. RFI subject.
 7. Specification Section number and title and related paragraphs, as appropriate.
 8. Drawing number and detail references, as appropriate.
 9. Field dimensions and conditions, as appropriate.
 10. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 11. Contractor's signature.
 12. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references and details of affected materials, assemblies, and attachments.
- C. Government's Action: Government will review each RFI, determine action required, and respond. Allow five (5) business days for Government's response for each RFI. RFIs received after 1:00p.m. will be considered as received the following working day.
 1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.

- e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Designer's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
- 2. Government's action may include a request for additional information, in which case Government's time for response will date from time of receipt of additional information.
- 3. Government's action on RFIs that may result in a change to the Contract Time, or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Government in writing within five (5) business days of receipt of the RFI response.
- D. RFI Log: The Government shall prepare and maintain an RFI Log for the Project. Log shall include:
 - 1. Project name.
 - 2. Name and address of Contractor.
 - 3. RFI number including RFIs that were returned without action or withdrawn.
 - 4. RFI description.
 - 5. Date the RFI was submitted.
 - 6. Date Government's response was received.
- E. On receipt of Government's response, Contractor shall immediately distribute the RFI response to affected parties under their responsibility. Review response and notify Government within five (5) business days if Contractor disagrees with response.

1.07 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. PDF Document Preparation: Where PDFs are required to be submitted to Government, prepare as follows:
 - 1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 - 2. Name file with submittal number or other unique identifier, including revision identifier.
 - 3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.08 PROJECT MEETINGS

- A. General: Schedule and conduct, with input from the Government, meetings and conferences at the Project site unless otherwise indicated.
 - 1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify the Government of scheduled meeting dates and times.
 - 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited parties.
 - 3. Minutes: Entity responsible for conducting the meeting shall record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including the Government, within five (5) business days of the meeting.
- B. Preconstruction Conference: Government will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Government, but no later than five (5) business days after execution of the Agreement.
 - 1. Attendees: Authorized representatives of Government, and their consultants; Contractor and their superintendents; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 2. Preconstruction Conference Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Responsibilities and personnel assignments.
 - b. Safety

- c. Tentative construction schedule, and process of developing Project Construction Schedule by Coordinating Contractor
 - d. Phasing.
 - e. Critical work sequencing and long lead items.
 - f. Designation of key personnel and their duties.
 - g. Lines of communications.
 - h. Use of web-based Project software.
 - i. Procedures for processing field decisions and Change Orders.
 - j. Procedures for RFIs.
 - k. Procedures for testing and inspecting.
 - l. Procedures for processing Applications for Payment.
 - m. Distribution of the Contract Documents.
 - n. Submittal procedures.
 - o. Preparation of Record Documents.
 - p. Use of the premises.
 - q. Work restrictions.
 - r. Working hours.
 - s. Owner's occupancy requirements.
 - t. Responsibility for temporary facilities and controls.
 - u. Procedures for moisture and mold control.
 - v. Procedures for disruptions and shutdowns.
 - w. Construction waste management and recycling.
 - x. Parking availability.
 - y. Office, work, and storage areas.
 - z. Equipment deliveries and priorities.
 - aa. First aid.
 - bb. Security.
 - cc. Progress cleaning.
- C. Preinstallation Conferences: Each Contractor shall conduct a preinstallation conference at Project site before each construction activity when required by other sections and when required for coordination with other construction. Each Contractor shall attend the preinstallation conference at the Project site with all pertinent personnel as defined in the Contract Documents or as requested by the Government. The Government may, at their discretion and at no additional cost to the Government, require a Contractor to conduct additional preinstallation conferences not identified in the Contract Documents.
- 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Government of scheduled meeting dates.
 - 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Safety
 - b. Contract Documents.
 - c. Options.
 - d. Related RFIs.
 - e. Related Change Orders.
 - f. Purchases.
 - g. Deliveries.
 - h. Submittals.
 - i. Review of mockups.
 - j. Possible conflicts.
 - k. Compatibility requirements.
 - l. Time schedules.

- m. Weather limitations.
 - n. Manufacturer's written instructions.
 - o. Warranty requirements.
 - p. Compatibility of materials.
 - q. Acceptability of substrates.
 - r. Temporary facilities and controls.
 - s. Space and access limitations.
 - t. Regulations of authorities having jurisdiction.
 - u. Testing and inspecting requirements.
 - v. Installation procedures.
 - w. Coordination with other Work.
 - x. Required performance results.
 - y. Protection of adjacent work.
 - z. Protection of construction and personnel.
3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Government will conduct progress meetings at biweekly intervals.
1. Called meetings and/or special meetings shall be as required by the progress of the Work.
 2. Location of the progress meetings: As designated by the Government.
 3. Attendees: In addition to representatives of Government, each Contractor, Subcontractor (as requested by Government), Supplier (as requested by Government), and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 4. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Project Construction Schedule Updating: Coordinating Contractor shall update Project Construction Schedule monthly in accordance with Section 01 32 00 - Construction Progress Documentation. Updated schedule shall be provided five (5) business days in advance of the first bi-weekly
 - 1) Progress Meeting of each month. After each progress meeting where revisions to the schedule have been made or recognized. Coordinating Contractor shall issue a revised updated schedule to Government for distribution.
- E. Project Closeout Conference: The Government will schedule and conduct a project closeout conference, at a time convenient to the Government, but no later than sixty (60) days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. Attendees: Authorized representatives of the Government; the Contractors and their superintendents; major Subcontractors, Suppliers and other concerned parties. Participants at the conference shall be familiar with the Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of record documents, including as-built surveys of SWM facilities.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.

- c. Procedures required prior to inspection(s) for Occupancy by the authority having jurisdiction.
 - d. Submittal of written warranties.
 - e. Requirements for preparing operations and maintenance data.
 - f. Requirements for delivery of material samples, attic stock and spare parts.
 - g. Requirements for demonstration and training.
 - h. Preparation of Contractor's punch list.
 - i. Procedures for processing Applications for Payment at Substantial Completion and Final Completion.
 - j. Submittal procedures.
 - k. Coordination of separate contracts.
 - l. Government's partial occupancy requirements, if any.
 - m. Responsibility for removing temporary facilities and controls.
 - n. Responsibility for transferring utility service(s).
- F. Superintendent Meetings: The General Trades Contractor will conduct Superintendent Meetings on a weekly basis.
- a. Additional meetings and/or special meetings shall be as required by the progress of the Work.
 - b. Location: Contractor's office trailer.
 - c. Attendance:
 - 1) Representative from all Contractors working on site or necessary for coordination of upcoming work.
 - 2) Subcontractor representatives as required or job conditions.
2. 2. Daily Reports: Each Contractor shall submit on a daily basis to the Government a daily report from the field concerning that day's work, deliveries, manpower and the like.

END OF SECTION

SECTION 01 32 00
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL**1.01 SUMMARY**

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Startup Construction Schedules.
 - 2. Project Construction Schedule.
 - 3. Project Construction Schedule Updating Reports.
 - 4. Field Manpower Reports.
 - 5. Site Condition Reports.
 - 6. Unusual Event Reports.

1.02 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.
 - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Critical Path Method (CPM): A method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine the critical path of Project and when activities can be performed.
- C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- D. Event: The starting or ending point of an activity.
- E. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Government or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

1.03 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. Working electronic copy of Project Construction Schedule file in Primavera P6.
 - 2. PDF copy of Schedule(s)
 - 3. PDF copies of Reports
- B. Startup Construction Schedule.
 - 1. Schedule consisting of the first sixty (60) days of activities from the date of Notice to Proceed.
- C. Project Construction Schedule (CPM Schedule): Complete project schedule, of size required to display entire schedule for entire construction period.
- D. Project Construction Schedule Updating Reports: Concurrent with CPM schedule, submit the updated Primavera P6 and each of the following reports.
 - 1. Activity Report
 - 2. Logic Report
 - 3. Total Float Report

- E. Site Condition Reports: Submit at time of discovery of differing conditions.
- F. Unusual Event Reports: Submit at time of unusual event.
- G. Qualification Data: For scheduling consultant.
 - 1. Coordinating Contractor shall designate a scheduling representative prior to submission of the initial CPM Schedule. The scheduling representative is the person primarily responsible for development and maintenance of the CPM schedule, the Contractor's representative in all matters regarding the schedule, and the designated attendee for all schedule-related meetings.

1.04 QUALITY ASSURANCE

- A. Scheduling Consultant Qualifications: Coordinating Contractor to submit the qualifications of the scheduling representative to the Government for acceptance within five (5) business days after the Notice to Proceed date. This is required before the CPM schedule will be accepted. The scheduling representative shall have at least three years of verifiable experience preparing and maintaining CPM project schedules on Projects of similar size and complexity.
- B. Prescheduling Conference: Government shall conduct a Preconstruction Conference at Project site to comply with requirements in Section 01 31 00 - Project Management and Coordination. All Contractors and their Superintendents are required to attend this meeting. At this Preconstruction Conference, Government will review methods, procedures and requirements related to the development of the Project Construction Schedule, including, but not limited to, the following:
 - 1. Review software limitations and content and format for reports.
 - 2. Verify availability of qualified personnel needed to develop and update schedule.
 - 3. Review dates information required by Contractors for development of the Project Construction Schedule by the Coordinating Contractor.
 - 4. Discuss constraints, including phasing, work stages, area separations, interim milestones, and partial Government occupancy as may be relevant to Project.
 - 5. Review delivery dates for Government-furnished products.
 - 6. Review schedule for work of Government's separate Contracts.
 - 7. Review submittal requirements and procedures.
 - 8. Review time required for review of submittals and resubmittals.
 - 9. Review time required for fabrication of materials and delivery to site.
 - 10. Review requirements for tests and inspections by independent testing and inspecting agencies.
 - 11. Review time required for Project closeout and Government startup procedures, including commissioning activities.
 - 12. Review and finalize list of construction activities to be included in Project Construction Schedule by the Coordinating Contractor.
 - 13. Review procedures for updating schedule.

1.05 COORDINATION

- A. Coordinate Contractor's Construction Schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from entities involved.
 - 2. Coordinate each construction activity in the network with other activities, and schedule them in proper sequence.

1.06 START UP SCHEDULE

- A. Within seven (7) calendar days of Notice to Proceed, each Contractor to provide to the Government a Gantt Chart schedule of activities, durations and general milestones of Work to take place in the first sixty (60) days after Notice to Proceed.

1.07 PROJECT CONSTRUCTION SCHEDULE

- A. As the Coordinating Contractor, the General Trades Contractor is responsible for the development and management of the overall Project Construction Schedule. Within fifteen (15) calendar days from issuance of Notice to Proceed date, each Contractor shall submit to the General Trades Contractor a schedule of their activities to complete their Work. Detail of activities shall be sufficient for General Trades Contractor to generate the Project Schedule including:
1. Name, Description and Duration of each Activity.
 2. Predecessor and Successor Activities (both within Contractor's Scope of Work, and that as it relates to Work of other Contractors)
 3. Required Milestones
 4. Additional requirements as noted below for overall Schedule Requirements.
- B. Schedule Requirements:
1. CPM Schedule: General Trades Contractor to prepare Project Construction Schedule using a time-scaled CPM network analysis diagram for the Work.
 - a. Develop and submit full CPM baseline schedule to Government within thirty (30) days after the Notice to Proceed date to allow sufficient time for adjustments as needed so it can be accepted by the Government for use no later than forty-five (45) days after date established for the Notice to Proceed.
 - 1) Mandatory Draft CPM Baseline Schedule Review Meeting: Upon receipt of the draft CPM baseline schedule, the Government will coordinate a meeting to review said schedule in detail with the Prime Contractors and their superintendents to ensure the schedule is accurate and all parties are in agreement of the schedule.
 - 2) Failure to include any work item required for performance of a Contract shall not excuse the Contractor from completing all work on or before applicable completion dates, regardless of Government's acceptance of the schedule.
 - b. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meetings and payment request dates.
 - c. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to coordinate with the Contract Time.
 2. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Final Completion.
 - a. Contract completion date to not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order
 3. Work Breakdown Structure (WBS): Provide a WBS for each construction area identifying major portions of the work. Major portions of work may be as follows but not limited to:
 - a. Phase, Area, Floor, Interior/Exterior of the Project, as well as the Procurement Process and Major Milestones.
 - b. Procurement Process WBS should be comprised of the following long lead items only:
 - 1) Prepare and Submit Shop Drawings/Product Data
 - 2) Review and Approve Shop Drawings/Product Data
 - 3) Fabricate and Deliver Materials
 - c. Major Milestones may comprise but are not limited to the following:
 - 1) Notice to Proceed (NTP)
 - 2) Mobilize to Site
 - 3) Sitework Complete
 - 4) Foundations Complete
 - 5) Structural Steel Complete
 - 6) Dry-In
 - 7) Mechanical Systems Complete

- 8) Electrical Systems Complete
 - 9) Plumbing Systems Complete
 - 10) Fire Suppression Systems Complete
 - 11) Conveying Systems Complete
 - 12) Required Substantial Completion Date
 - 13) Closeout Activities
 - 14) Final Completion
4. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
 - a. Activity Duration: Define activities so no activity is longer than twenty (20) business days unless specifically allowed by Government.
 - b. Procurement Activities: Include procurement process activities in the corresponding WBS for long lead items and major items requiring a cycle of more than sixty (60) days as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - c. Submittals Review Time: The reviews and comments by the Government will be completed within twenty (20) business days after submission to the respective party. Coordinating submittal review times in Project Construction Schedule with submittal schedule.
 - d. Commissioning Time: Include no fewer than fifteen (15) business days for commissioning.
 - e. Startup and Testing Time: Include no fewer than fifteen (15) business days for startup and testing.
 - f. Substantial Completion: Indicate completion in advance of date established for Substantial Completion and allow time for Government's administrative procedures necessary for certification of Substantial Completion.
 - g. Punch List and Final Completion: Include not more than thirty (30) days for completion of punch list items and Final Completion.
 5. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule and show how the sequence of the Work is affected.
 - a. Phasing: Arrange list of activities on schedule by phase in the Work Breakdown Structure (WBS) as noted above.
 - b. Products Ordered in Advance: Include a separate activity for each product. Delivery dates indicated stipulate the earliest possible delivery date.
 - c. Government-Furnished Products: Include a separate activity for each product. Delivery dates indicated stipulate the earliest possible delivery date.
 - d. Work Restrictions: Show the effect of the following items on the schedule:
 - 1) Coordination with existing construction.
 - 2) Limitations of continued occupancies.
 - 3) Uninterruptible services.
 - 4) Partial occupancy before Substantial Completion.
 - 5) Use of premises restrictions.
 - 6) Provisions for future construction.
 - 7) Seasonal variations.
 - 8) Environmental control.
- C. Contract Modifications: Include each proposed Contract Modification in the CPM schedule.
 - D. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:
 1. Contractor or subcontractor and the Work or activity.
 2. Immediately preceding and succeeding activities.
 3. Early and late start dates.
 4. Early and late finish dates.

5. Activity duration in workdays.
 6. Total float.
- E. Schedule Updating: On Monthly intervals, General Trades Contractor shall, concurrent with making revisions to schedule, prepare tabulated reports showing the following:
1. Identification of activities that have changed.
 2. Changes in early and late start dates.
 3. Changes in early and late finish dates.
 4. Changes in activity durations in workdays.
 5. Changes in the critical path.
 6. Changes in total float.
 7. Changes in the Contract Time.
- F. Recovery Schedule: When periodic update indicates the Work is twenty (20) or more calendar days behind the current accepted schedule, the Government may invoke the right to have the General Trades Contractor submit a separate recovery schedule indicating means by which the Contractor(s) intend to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance and date by which recovery will be accomplished.
- G. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
1. Use Primavera P6.
- H. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting, using CPM scheduling.
1. In-House Option: Government may waive requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
 2. Meetings: Scheduling Consultant to be available upon request by the Government for meetings related to Project progress, alleged delays, and time impact.
- I. Look Ahead Schedules: Each Contractor to prepare summary report indicating activities scheduled to occur or commence within the next 2-week period. Summary to be provided two (2) business days in advance of the Bi-Weekly Progress Meeting. Summarize the following issues:
1. Upcoming Work
 2. Unresolved issues.
 3. Unanswered Requests for Information.
 4. Rejected or unreturned submittals.
 5. Notations on returned submittals.
 6. Pending modifications affecting the Work and the Contract Time.
- J. Project Construction Schedule Updating: At monthly intervals, each Contractor shall update their schedule of activities to reflect actual construction progress. Each Contractor shall issue their updated schedules to the General Trades Contractor five (5) business days before the first regularly scheduled Progress Meeting of each month. The General Trades Contractor will utilize the other Contractor's schedules to:
1. Update Project Construction Schedule for distribution to the Government prior to the Progress Meeting. If during the Progress Meetings, additional changes are noted, General Trades Contractor shall Immediately after the meeting issue a revised updated Project Construction Schedule for distribution.
 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate Final Completion percentage for each activity.
- K. Mandatory Monthly Project Schedule Update Meetings: Within 48-hours of the Construction Manager's receipt of the monthly schedule update, a meeting will be held to review said

schedule in detail with the Prime Contractors and their superintendents to ensure the updated schedule is accurate and all parties are in agreement of the schedule.

- L. Distribution: Distribute copies of approved schedule to Contractors, testing and inspecting agencies, and other parties identified by Government with a need-to-know schedule responsibility.
 - 1. Post copies in Project meeting rooms and temporary field offices.
 - 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

1.08 REPORTS

- A. Project Construction Reports: Concurrent with CPM Schedule, submit the updated Primavera P6 file and each of the following reports. Format for each activity in reports shall contain activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
 - 1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
 - 2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 - 3. Total Float Report: List of all activities sorted in ascending order of total float.
- B. Field Manpower Reports Prepare a daily construction report recording the following information concerning events at Project site for Contractor's Work:
 - 1. List of subcontractors at Project site.
 - 2. Approximate count of personnel at Project site
 - 3. Equipment at Project site.
 - 4. Material deliveries.
 - 5. High and low temperatures and general weather conditions, including presence of rain or snow.
 - 6. Testing and inspection.
 - 7. Accidents.
 - 8. Meetings and significant decisions.
 - 9. Unusual events.
 - 10. Stoppages, delays, shortages, and losses.
 - 11. Meter readings and similar recordings.
 - 12. Emergency procedures.
 - 13. Orders and requests of authorities having jurisdiction.
 - 14. Change Orders received and implemented.
 - 15. Construction Change Directives received and implemented.
 - 16. Services connected and disconnected.
 - 17. Equipment or system tests and startups.
 - 18. Partial completions and occupancies.
 - 19. Substantial Completions authorized.
- C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.
- D. Unusual Event Reports: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, responses by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Government in advance when these events are known or predictable.

1. Submit unusual event reports directly to Government within one (1) business day of an occurrence. Distribute copies of report to parties affected by the occurrence.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

**SECTION 01 33 00
SUBMITTAL PROCEDURES**

PART 1 - GENERAL**1.01 SUMMARY**

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, Mockups, Preinstallation Meeting Minutes and other submittal Items.

1.02 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Government's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Government's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

1.03 INFORMATION SUBMITTALS

- A. Government will review each submittal and will return it if it does not comply with requirements.

1.04 ACTION SUBMITTALS

- A. Submittal Register: The Government will distribute a register of submittals from the Contract Specifications and/or drawings to the Prime Contractors. The Prime Contractors will endeavor to provide all submittals in a timely fashion to not impact or delay the performance of work.
- B. Government will review each submittal, make marks to indicate corrections or revisions required, and return it. Government will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

1.05 SUBMITTAL FORMAT

- A. Submittal Information: Contractor to utilize the provided AF form 3000 and include the following information with each submittal:
 - 1. Date.
 - 2. Name of Contractor.
 - 3. Name of firm or entity that prepared submittal.
 - 4. Names of subcontractor, manufacturer, and supplier.
 - 5. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier, and alphanumeric suffix for resubmittals.
 - 6. Category and type of submittal.
 - 7. Submittal purpose and description.
 - 8. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
 - 9. Drawing number and detail references, as appropriate.
 - 10. Indication of full or partial submittal.
 - 11. Location(s) where product is to be installed, as appropriate.
 - 12. Other necessary identification.
 - 13. Remarks.
 - 14. Signature of transmitter.
- B. Options: Identify options requiring selection by Government.
- C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Government on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

- D. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

1.06 SUBMITTAL PROCEDURES

- A. Designer's Digital Data Files: Electronic digital data files of the Contract Drawings may be available upon request from Designer for Contractor's use in preparing submittals. Designer makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to Government.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Submit action submittals and informational submittals required by the same Specification Section under a single transmittal. Do not place various specification sections under a single transmittal.
 2. Designer and Government reserve the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Government will verify completeness and process submittal for review. Time for review shall commence on Government's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance to of the Work to permit processing, including resubmittals.
1. Initial Review: Allow fifteen (15) business days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Government will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in the same manner as initial submittal.
 3. Resubmittal Review: Allow ten (10) business days for review of each resubmittal.
- D. Electronic Submittals: Electronic Submittals are required for this project and shall be submitted to recipients as designated by the Government. Submittals are to be provided in PDF format. Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into a single file incorporating submittal requirements of a single Specification Section.
 2. Name file with unique activity identifier as per the referenced Submittal Register. Should a submittal be required which is not identified in the submittal register, notify the Government. The submittal register is
 - a. provided for reference purposes only. The Contractor is responsible for providing all required submittals, including those which may have been omitted from the submittal register.
 3. Transmittal Cover Sheet for Electronic Submittals: Ensure the provision of transmittal cover sheet for all submittals. Permanently record Contractor's review and approval markings, including date of approval, on transmittal cover sheet. Submittals which do not include the Contractor's stamp of acceptance will be returned to the Contractor with no action taken.
 4. Submittals shall clearly indicate the products to be used on the Project. Submittals containing an entire catalog of products (or similar) that do not specifically indicate the product(s) to be used will be sent back to the Contractor for resubmission.
- E. Resubmittals: Make resubmittals in same form as initial submittal. Note date and content of revision in label or title block and clearly indicate extent of revision. Resubmit submittals until they are marked with approval notation from Government's action stamp.
- F. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed. Attach label on unexposed side of Samples that includes the Specification Section, product name and name of manufacturer and

unique identifier, if applicable. Samples are the property of the Government unless otherwise designated.

1. Samples shall be shipped and/or delivered to a location(s) designated by the Government.
- G. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- H. Use for Construction: Retain complete electronic copies of submittals on Project Site. Use only final action submittals that are marked with acceptance notation from Designer's and Construction Manager's action stamp.
- I. Discrepancies: In the event of review status discrepancy, the Government's action stamps take precedence. The Contractor is responsible for reviewing the incorporated review comments of every returned submittal.
- J. Provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
- K. All Work must have an approved submittal prior to procurement and installation. Failure to obtain approvals for materials in a timely manner shall not relieve the Contractor of their responsibility to maintain schedule. Failure by the Contractor to obtain approved submittals in a timely manner does not constitute a claim against the Government for their actions.

1.07 SUBMITTAL REQUIREMENTS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams that show factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.
- B. Shop Drawings: Prepare Project specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on Designer's digital data drawing files is otherwise permitted.
 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.

- g. Seal and signature of professional engineer if specified.
- C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.
 - 1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 - 2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
 - a. Project name and submittal number.
 - b. Generic description of Sample.
 - c. Product name and name of manufacturer.
 - d. Sample source.
 - e. Number and title of applicable Specification Section.
 - f. Specification paragraph number and generic name of each item.
 - 3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics, and identification information for record.
 - 4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Government's property, are the property of Contractor.
 - 5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit one (1) full set (s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Government, will return submittal with options selected.
 - 6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture and pattern; color range sets; and components used for independent testing and inspection.
 - a. Number of Samples: Submit three (3) sets of Samples. Government will retain two (2) sample sets; remainder will be returned.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three
 - (a) (3) sets of paired units that show approximate limits of variations.
- D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 - 1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 - 2. Manufacturer and product name, and model number if applicable.
 - 3. Number and name of room or space.
 - 4. Location within room or space.

- E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of Designers and Owners, and other information specified.
- F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- G. Certificates:
 - 1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
 - 2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
 - 3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
 - 4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
 - 5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
 - 6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- H. Test and Research Reports:
 - 1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
 - 2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
 - 3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
 - 4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
 - 5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by qualified testing agency.
 - 6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - a. Name of evaluation organization.
 - b. Date of evaluation.
 - c. Time period when report is in effect.
 - d. Product and manufacturers' names.
 - e. Description of product.
 - f. Test procedures and results.

- g. Limitations of use.

1.08 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Government.
- B. Delegated Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.09 CONTRACTOR'S REVIEW

- A. Action Submittals and Informational Submittals: Contractor shall review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Government.
- B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
 - 1. Government will not review submittals received from Contractor that do not have Contractor's review and approval.

1.10 DESIGNER'S AND CONSTRUCTION MANAGER'S REVIEW

- A. Action Submittals: Government will review each submittal, indicate corrections or revisions required, and return submittal noted.
- B. Informational Submittals: Informational submittals will be reviewed and returned if not in compliance with requirements.
- C. Submittals: Designer will indicate, via markup on each submittal, the appropriate action, as follows:
 - 1. Conforms: The Contractor is advised that the submission is in general conformance with the design concept and contract documents. Fabrication, installation or erection may be undertaken. Final payment depends on that compliance. Submittals stamped as such do not authorize changes to Contract Price.
 - 2. Conforms as Noted (Resubmission Not Required): The Contractor is advised that the submission is in general conformance with the design concept and contract documents as noted. Contractor shall comply with all notes or corrections indicated. No resubmittal is required. Any corrections or variations should be noted on record drawings and files. Final payment depends on that compliance. If for any reason the Contractor cannot comply with the noted corrections, fabrications shall not proceed, and the Contractor shall resubmit for review.
 - 3. Revise & Resubmit: The Contractor is advised that the submittal shall be revised and resubmitted. Any submittal marked "Revise and Resubmit" will not be permitted on the project site. Neither fabrication, installation nor erection shall be undertaken.
 - 4. Receipt Acknowledged: Submission not subject to engineering review and considered for record only.
- D. The review and approval of a submittal by the Designer is for conformance with the information given in the Contract Documents and with the design concept of the Project. Approval does not relieve the Contractor of the responsibility for compliance with Contract requirements or with

statutory or regulatory requirements. The Contractor is responsible for dimensions, quantities, details, connections, fabrication, construction methods and coordination of trades required for satisfactory construction of all Work.

- E. Partial and incomplete submittals prepared for a portion of the Work are unacceptable, will be considered non-responsive and will be returned to the Contractor without action. The Contractor shall assemble complete submittals that include all related and specified work within a specification section. If partial review consideration is required by the Contractor, the Contractor must advise the Government and receive approval from Government before submitting partial submittals.
- F. Submittals not required by the Contract Documents may be returned by the Designer without action.
- G. Government will return without review submittals received from sources other than Contractor.
- H. Any work completed without an approved submittal is work completed at the contractor's own risk and if the work is unapproved, the contractor is 100% responsible for installing the correct material at their own cost.

END OF SECTION

**SECTION 01 35 46
INDOOR AIR QUALITY PROCEDURES**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. General requirements for sustainable design reporting.
 - 1. This project intends to be constructed using procedures and documentation complying with the federally mandated "Guiding Principles" (GP), Third Party Certification (TPC) requirements (if applicable), UFC 1-200-02, High Performance and Sustainable Building Requirements, and other requirements identified in this specification.

1.02 REPORTING REQUIREMENTS

- A. Contractor must familiarize himself with the relevant reporting requirements and provide the necessary information and instruction to all subcontractors and installers.

1.03 DEFINITIONS

- A. Indoor Air Quality (IAQ) Management Plan: Plan developed by the Contractor to provide a healthy indoor environment for workers and building occupants during construction. Plan must meet or exceed the recommendations of SMACNA (OCC) 'IAQ Guidelines for Occupied Buildings Under Construction'.

1.04 PRODUCT REPORTING SCOPE

- A. General: Product reporting scope for the purpose of achieving the selected sustainability certification level is limited to those items directly affecting ability to achieve targeted points.

1.05 REFERENCE STANDARDS

- A. SMACNA (OCC) - IAQ Guidelines for Occupied Buildings Under Construction.
- B. UFC 1-200-02 - High Performance and Sustainable Building Requirements.

1.06 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for additional submittal procedures requirements.
- B. Indoor Air Quality (IAQ) Management Plan: Not less than 10 business days before the Pre-construction meeting, prepare and submit an IAQ Management Plan including, but not limited to, the following:
 - 1. Procedures for control of emissions during construction.
 - a. Identify schedule for application of interior finishes.
 - 2. Procedures for moisture control during construction.
 - a. Identify porous materials and absorptive materials.
 - b. Identify schedule for inspection of stored and installed absorptive materials.
- C. Product Data:
 - 1. Submit product data for filtration media used during construction and during operation. Include Minimum Efficiency Reporting Value (MERV).
 - 2. Material Safety Data Sheets: Submit MSDSs for inclusion in Operation and Maintenance Manual for the following products.
 - a. Adhesives.
 - b. Floor and wall patching/leveling materials.
 - c. Caulking and sealants.
 - d. Insulating materials.
 - e. Fireproofing and firestopping
 - f. Paint.
 - g. Clear finish for wood surfaces.
 - h. Lubricants.
 - i. Cleaning products.

- j. Carpeting.
- D. Inspection and Test Reports:
 - 1. Moisture control inspections.
- E. Sustainable Design Documentation: The scope of required documentation is specified in this section and in applicable individual specification sections.

PART 2 PRODUCTS - NOT USED**PART 3 EXECUTION****3.01 IAQ MANAGEMENT - EMISSIONS CONTROL**

- A. Provide point person responsible for the implementation and assurance that the Indoor Air Quality Plan is being implemented.
- B. Flush-Out: After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying outdoor air while maintaining an internal temperature of at least 60 degrees F and relative humidity no higher than 60%. Determine total volume of outside air as defined by Equation 10-1 in IgCC 1001.3.1.5.

3.02 IAQ MANAGEMENT - MOISTURE CONTROL

- A. Materials stored on-site or materials installed that are absorptive shall be protected from moisture damage.
- B. Building construction materials that show visual evidence of biological growth due to the presence of moisture shall not be installed on the building project.
- C. Verify that installed materials and products are dry prior to sealing and weatherproofing the building envelope.

3.03 IAQ MANAGEMENT - TOBACCO SMOKE CONTROL

- A. Prohibit smoking within the building and within a minimum of 50 feet of all building entrances, operable windows, and building ventilation intakes.

END OF SECTION

**SECTION 01 40 00
QUALITY REQUIREMENTS**

PART 1 - GENERAL**1.01 REFERENCE STANDARDS**

- A. 29 CFR 1910 - Occupational Safety and Health Standards.
- B. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality assurance and quality control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and quality-control services required by Government or authorities having jurisdiction are not limited by provisions of this Section.
 - 4. Specific test and inspection requirements are not specified in this Section.
- C. Related Requirements:
 - 1. Section 01 45 23 - Testing and Inspection Services.

1.03 DEFINITIONS

- A. Quality Assurance Services: Activities, actions and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality Control Services: Tests, inspections, procedures and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by the Government.
- C. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five (5) previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- D. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- E. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
 - 1. Use of trade-specific terminology in referring to a Work result does not require that that certain construction activities be performed by accredited or unionized individuals or that certain construction activities specified apply exclusively to specific trade(s).
- F. Mockups: Full-size physical assemblies that are constructed on the project site. Mockups are constructed to verify selections made under sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing or operation; to show interface between dissimilar materials; and to demonstrate compliance with

specified installation tolerances. Mockups are NOT samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.

1. Mockups are used for one or more of the following:
 - a. Verify selections made under Sample submittals.
 - b. Demonstrate aesthetic effects.
 - c. Demonstrate the qualities of products and workmanship.
 - d. Demonstrate successful installation of interfaces between components and systems.
 - e. Perform preconstruction testing to determine system performance.
 2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
 3. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.
 4. Laboratory Mockups: Full-size physical assemblies constructed at a testing facility to verify performance characteristics.
 5. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on the project side, consisting of multiple products, assemblies and subassemblies.
 6. Room Mockups: Mockups of typical interior spaces complete with wall, floor and ceiling finishes, doors, windows, millwork, casework, specialties, furnishings, equipment and lighting.
- G. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or
1. compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.
- H. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) in accordance with 29 CFR 1910.7, by a testing agency accredited in accordance with NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- I. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.
- J. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "testing agency."
- K. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- L. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Government.

1.04 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Designer.
- B. Delegated Design Services Statement: Submit a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.05 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement at no additional cost to the Government and inform the Government regarding the conflict. Refer conflicting requirements that are different, but apparently equal, to Government for clarification before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified is the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Government for a decision before proceeding.

1.06 ACTION SUBMITTALS

- A. Mockup Shop Drawings:
 - 1. Include plans, sections, elevations, and details, indicating materials and size of mockup construction.
 - 2. Indicate manufacturer and model number of individual components.
 - 3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.07 INFORMATIONAL SUBMITTALS

- A. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- B. Permits, Licenses, and Certificates: For Owner's record, submit to Government copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.
- C. Schedule of Tests and Inspections: After 30 calendar days from Notice to Proceed, prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of tests and inspections.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality control service.

1.08 CONTRACTOR'S QUALITY CONTROL ITEMS

- A. Quality Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality assurance and quality control procedures similar in nature and extent to those required for the Project.
- B. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- C. Testing and Inspection: In quality control plan, include a comprehensive schedule of Work requiring testing and inspection, including the following:
 - 1. Contractor-performed tests and inspections: include subcontractor-performed tests and inspections required by the Contract Documents.

2. Government-performed tests and inspections: Special Inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections." Include required tests and inspections and Contractor-elected tests and inspections.
- D. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance standards of workmanship established by Contract requirements and approved mockups.
- E. Monitoring and Documentation: Maintain testing and inspection reports and a log of approved and rejected results. Include work the Government has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.09 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Contractor shall prepare and submit certified written reports specified in other Sections. Include the following:
 1. Date of issue.
 2. Project title.
 3. Name, address and telephone number of factory-authorized service representative issuing report.
 4. Statement that equipment complies with requirements.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
 8. Name, address and telephone number of testing agency.
 9. Dates and locations of samples, tests and inspections.
 10. Names of individuals taking samples or making tests and inspections.
 11. Description of the Work and the sampling, testing and/or inspection method.
 12. Identification of project and Specification Section.
 13. Complete test or inspection data.
 14. Test and inspection results and an interpretation of the results.
 15. Record of temperature and weather conditions at the time of sampling, testing and inspection.
 16. Comments or professional opinion on whether sampled, tested or inspection Work complies with the requirements of the Contract Documents.
 17. Name and signature of laboratory inspector.
 18. Recommendations for re-testing or re-inspection.
- B. Manufacturer's Technical Representative's Field Reports: Contractor shall prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
 1. Name, address and telephone number of technical representative issuing report.
 2. Statement on condition of substrates and their acceptability for installation of the product.
 3. Statement that products at the Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products and installation will affect warranty provisions.
 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Contractor shall prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address and telephone number of factory-authorized service representative issuing report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement whether conditions, products and installation will affect warranty.
5. Other required items indicated in individual Specification Sections

1.10 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work 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.
- E. 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 the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.
 1. Requirements of authorities having jurisdiction supersede requirements for specialists.
- G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extend to those indicate for this project.
- J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.

- b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Provide sizes and configurations of test assemblies, mockups and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. Build site-assembled test assemblies and mockups using installers who will perform the same tasks for the Project.
 - e. Build laboratory mockups at testing facility using personnel, products and methods of construction indicated for the completed Work.
 - f. When testing is complete, remove test specimens, assemblies and mockups; do not reuse products on the Project.
- 2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Government, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 - 1. Build mockups of size indicated.
 - 2. Build mockups in location indicated or, if not indicated, as directed by Government.
 - 3. Notify Government five (5) business days in advance of dates and times when mockups will be constructed.
 - 4. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed to perform same tasks during the construction at Project.
 - 5. Demonstrate the proposed range of aesthetic effects and workmanship.
 - 6. Obtain Government's approval of mockups before starting corresponding work, fabrication, or construction.
 - a. Allow Seven (7) calendar days for initial review and each re-review of each mockup.
 - 7. Promptly correct unsatisfactory conditions noted by Government's preliminary review, to the satisfaction of the Government, before completion of final mockup.
 - 8. Approval of mockups by the Government does not constitute approval of deviations from the Contract Documents contained in mockups unless Government specifically approves such deviations in writing.
 - 9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 10. Demolish and remove mockups when directed unless otherwise indicated.
- L. Integrated Exterior Mockups: Construct integrated exterior mockup according to accepted Shop Drawings. Coordinate installation of materials and products for which mockups are required in individual Specification Sections, along with supporting materials.

1.11 QUALITY CONTROL

- A. Government Responsibilities: Where quality-control services are indicated as Government's responsibility, Government will engage a qualified testing agency to perform these services.
 - 1. Government will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
 - 2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Government are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
 - 1. Unless otherwise indicated, provide quality control services specified and those required by authorities having jurisdiction, whether specified or not.

2. Engage a qualified testing agency to perform these quality control services.
 - a. Contractor shall not employ same entity engaged by the Government unless agreed to in writing by the Government.
 3. Notify testing agencies at least twenty-four (24) hours in advance of time when Work that requires testing or inspection will be performed.
 4. Submit a certified written report of each quality control service.
 5. Testing and inspection requested by the Contractor and not required by the Contract Documents are the Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction when they so direct.
- C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 45 23 - Testing and Inspection Services.
- D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- E. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.
 5. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 6. Security and protection for samples and for testing and inspection equipment at Project site.
- F. Coordination: Coordinate sequence of activities to accommodate required quality- assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 - PRODUCTS (NOT USED)**PART 3 - EXECUTION****3.01 ACCEPTABLE TESTING AGENCIES**

- A. Testing Agency credentials shall be submitted to the Government for approval.

3.02 TEST AND INSPECTION LOG

- A. Prepare a record of tests and inspections. Include the following:
1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Government.
 4. Identification of testing agency conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Government's reference during normal working hours.
1. Submit log at Project closeout as part of Project Record Documents.

3.03 REPAIR AND PROTECTION

- A. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 - 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams
 - a. that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 00 - Execution.
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION

SECTION 01 45 23
TESTING AND INSPECTION SERVICES

PART 1 - GENERAL**1.01 REQUIREMENTS INCLUDED**

- A. Provision of Testing Laboratory Services.

1.02 DESCRIPTION

- A. The Government will provide Special Inspections and Testing Services for the project as outlined on Contract Drawing.
- B. The balance of required Quality Control tests and inspections shall be coordinated and paid for by the Contractor requiring such testing or inspection to complete their work.
- C. Employment of a testing laboratory shall in no way relieve the Contractor of obligation to perform the Work in accordance with requirements of the Contract Documents.

1.03 REFERENCE STANDARDS

- 1. ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
- 2. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

1.04 QUALITY ASSURANCE

- A. Comply with requirements of ASTM D3740 and ASTM E329.
- B. Testing Laboratory Qualification: Laboratory shall be accredited to comply with this specification. A certificate of accreditation, including the scope of accreditation, shall be submitted to the Government.
 - 1. Laboratory shall be authorized to operate in the State in which the Project is located.
- C. Laboratory Representative: Laboratory shall maintain a full-time, registered Professional Engineer on staff to review services.
- D. Inspecting or Testing Technician: Technicians shall have sufficient education and training to demonstrate competence for the test or inspection that is being conducted. Technicians sampling or testing construction materials on the Project site shall be certified by the qualified national authority appropriate to the service being provided. Copies of all certifications shall be submitted to the Government.
- E. Testing Equipment: Shall be calibrated at reasonable intervals with devices of an accuracy traceable to either NIST standards or accepted values of natural physical constraints.

1.05 CONTRACTOR SUBMITTALS

- A. Prior to start of work, submit testing laboratory name, address, telephone number and names of full-time registered Professional Engineer and Responsible Officer to the Government. Include qualification data to demonstrate their capabilities and experience.
- B. Submit report of laboratory facilities inspection made by the Materials Reference Laboratory of the National Institute of Standards and Technology during their most recent tour of inspection, including memorandum of remedies and any deficiencies reported during the inspection.

1.06 LABORATORY RESPONSIBILITIES

- A. Test samples of mixes submitted by the Contractor.
- B. Obtain samples of materials for testing at the source or at the project site, as applicable.
- C. Provide qualified personnel at the project site after due notice; cooperate with the Government and Contractor in performance of services.
- D. Perform specified inspections, sampling and testing of products in accordance with specified standards.

- E. Ascertain compliance of materials and mixes with requirements of Contract Documents.
- F. Perform additional tests and inspections as required by the Government.
- G. Promptly notify Government and Contractor of observed irregularities or non-conformance of Work or products

1.07 LABORATORY REPORTS

- A. After each test and/or inspection, promptly submit one (1) PDF copy of the report to the Contractor and the Government. Report shall include:
 - 1. Date issued.
 - 2. Project title and number.
 - 3. Name of inspector.
 - 4. Date and time of sampling and/or inspection.
 - 5. Identified of product.
 - 6. Reference to applicable Specification section.
 - 7. Location of sample or test on the project site.
 - 8. Type, date and time of test or inspection.
 - 9. Results of test and compliance with Contract Documents.

1.08 LIMITS ON TESTING LABORATORY AUTHORITY

- A. Laboratory MAY NOT release, revoke, alter or enlarge on requirements of the Contract Documents.
- B. Laboratory MAY NOT approve or accept any portion of the Work.
- C. Laboratory MAY NOT assume any duties of the Contractor.
- D. Laboratory HAS NO AUTHORITY to stop the Work.

1.09 CONTRACTOR RESPONSIBILITIES

- A. Notify the Government at least twenty-four (24) hours in advance of time when Work that requires testing or inspection will be performed. This is to include both the Special Inspection and Testing provided by the Government and the Contractor's Quality Control testing and inspection.
- B. Cooperate with laboratory personnel and provide access to the Work and/or to manufacturer's facilities, as appropriate.
- C. Provide incidental labor and facilities to:
 - 1. Provide access to Work to be tested.
 - 2. Facilitate testing and inspection.
 - 3. Provide for proper storage and curing of test samples in accordance with direction from testing agency.

1.10 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Government will engage a qualified testing agency or special inspector to conduct special tests and inspections required by authorities having jurisdiction, as indicated in the Statement of Special Inspections on the Contract Drawings, and as follows:
 - 1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
 - 2. Notifying Government and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 - 3. Submitting a certified written report of each test, inspection, and similar quality-control service to Government, with copy to Contractor and to authorities having jurisdiction.
 - 4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 - 5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 - 6. Retesting and reinspecting corrected Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL**1.01 SUMMARY**

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

1.02 REFERENCE STANDARDS

- A. NFPA 10 - Standard for Portable Fire Extinguishers.
- B. NFPA 70 - National Electrical Code.
- C. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.

1.03 SPECIFIC REQUIREMENTS

- A. This Section specifies requirements for temporary services and facilities including utilities, Construction, and support facilities, and security and protection as specified below. The Scope of work includes installation, maintenance, and removal of utilities and or systems.
- B. Temporary utilities required include, but are not limited to:
 - 1. Temporary Power: The Electrical Contractor will install temporary power as required for the Project and the Office Trailers of all Contractors and shall furnish and install temporary electrical power and lighting distribution systems of adequate size and performance necessary for the Project. Temporary electric shall be OSHA, NECA, and UL compliant and installed as per the National Electric Code.
 - a. The Electrical Contractor will contact the Power Company representative to make arrangements for temporary power for the Project and the Office Trailers. The Electrical Contractor shall provide temporary electric service to a secondary service pole, meter, and distribution panel which shall be located on the Project site in locations acceptable to the Government. The Electrical Contractor will pay all costs for temporary service.
 - b. Electrical Contractor shall furnish and install all conduit, cabling, ground rods, transformers, panels, disconnects, breakers, anchors, poles, guy wires, etc. required to provide temporary electrical service.
 - c. Electrical Contractor shall be responsible for all connection fees and charges and all usage fees for the duration of the Project.
 - d. The Electrical Contractor shall patch construction materials where temporary power has penetrated walls. Landscaping, grass areas, paved areas, concrete, etc. where temporary poles or underground service was installed shall be restored to the original surface condition.
 - 2. Temporary Water and Sewer: The General Trades Contractor shall provide water and sewer service and distribution as required for the Work.
 - a. The General Trades Contractor shall maintain strict supervision of the operation of the temporary water systems, including energy conservation, safe practices, protection from abuse, and protection from freezing.
 - b. The General Trades Contractor will be responsible for procuring any water required to perform the work on the project, as no water will be available onsite nor will be furnished by the Government.
 - 3. Temporary Gas/Propane: Each Contractor shall provide temporary gas/propane as required for their Work or Office Trailer. and shall furnish and install temporary gas/propane distribution systems as adequate size and performance necessary of the Work.
- C. Temporary Construction and Support Facilities required include, but are not limited to:
 - 1. All Contractors
 - a. Each Contractor shall coordinate deliveries, delivery times, and laydown locations with the Government.

- b. Each Contractor shall provide bracing and shoring as necessary to protect existing utilities from damage from their Work.
 - c. Each Contractor shall provide shoring, hoists, ladders, scaffolding, barricades, ramps, etc. necessary for the work of their Contract.
 - d. Each Contractor is responsible to keep site debris off the local roads, provide dust, noise control, provide daily clean-up, and trash removal resulting from the work or employees of their Contract.
 - e. Each Contractor shall furnish safety and first aid supplies necessary for their Workers and Subcontractors.
 - f. Technology services for each Contractor's own needs shall be the responsibility of each Contractor.
2. General Trades Contractor
- a. The General Trades Contractor shall install, maintain, and remove erosion and sedimentation controls for the Project, including the concrete washout containment device. This Contractor shall conduct a pre-installation meeting with the Government, and County Conservation District not less than five (5) business days prior to commencement of work. Contractor shall document the results of this meeting and submit to the Government.
 - b. The General Trades Contractor shall provide and maintain the rock construction entrance(s), temporary roads, and paved areas in accordance with the Contract Documents or as necessary for execution of the Work.
 - c. The General Trades Contractor shall provide mowing and maintenance of lawns within the construction areas as required by the Specifications until Substantial Completion of the Project. This includes vegetation control throughout the entire site during construction.
 - d. The General Trades Contractor shall provide sweeping, cleaning, and snow removal of all drives, parking lots, and roadways throughout the duration of the Project.
 - e. The General Trades Contractor shall provide sanitary facilities.
 - f. The General Trades Contractor shall provide dumpsters for disposal of all non hazardous demolition and construction debris and general waste.
 - g. The General Trades Contractor shall provide temporary stairs until permanent stairs are available and where ladders are not adequate.
 - h. The General Trades Contractor shall provide temporary construction walk- off/sticky mats at all construction entrances once final flooring materials are installed.
- D. Security and Protection Facilities required include, but are not limited to:
- 1. The General Trades Contractor shall provide and maintain traffic control measures in accordance with the Contract Documents.
 - 2. The General Trades Contractor shall provide signs for directions, warnings, deliveries, and general safety. Any specific safety signage required due to Work of a Contractor is the responsibility of that Contractor.
 - 3. The General Trades Contractor shall provide barricades and warning signs.
 - 4. The General Trades Contractor shall be responsible to provide and maintain site enclosure fencing, access gates, chains, and padlock(s) to secure the property.
 - 5. General Trades Contractor shall provide temporary fire protection and extinguishers. Each Contractor is responsible for fire protection measures for "hot work" of their Contract.
- E. Quality Assurance
- 1. Regulations: All Contractors and trades shall comply with industry standards and applicable laws and regulations of authorities having jurisdiction, including but not limited to:
 - a. Government specific requirements.
 - b. Municipal and Department of Labor & Industry Building Code requirements.
 - c. State, and Local health and safety statutes.
 - d. Utility Company regulations.
 - e. Police, Fire Department, and EMS rules.

- f. Environmental protection regulations.
- F. Inspections: The Contractor furnishing the temporary utility or system shall arrange for authorities having jurisdiction to inspect and test each temporary utility before use and obtain required certifications and permits. Contractor shall provide copies of the results of all inspections and tests to the Government.

1.04 USE CHARGES

- A. General: Installation, removal, and use charges for temporary facilities to be included in the Contract Sum of installing Contractor unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, testing agencies, and authorities having jurisdiction.
- B. Sewer Service: The General Trades Contractor will pay for the sewer service use charges for sewer usage by all entities for construction operations.
- C. Water Service: The General Trades Contractor will pay for the water service use charges for water used by all entities for construction operations.
- D. Gas/Propane Service: Each Contractor shall pay for the gas/propane service use charges for gas/propane used for their Work and shall provide connections and extensions of services as required for construction operations.
- E. Electrical Power Service: The Electrical Contractor will pay for electric power service use charges for electricity used by all entities used for construction operations.

1.05 CONDITIONS OF USE

- A. Conditions of Use: Each Contractor shall keep temporary facilities clean and neat in appearance, operate in a safe and efficient manner and take necessary fire prevention measures. Contractors will not overload facilities or permit them to interfere with progress. Contractors will not allow hazardous or unsanitary conditions or public nuisances to develop or persist on the site. Contractors shall report any unsafe conditions to the General Trades Contractor and Government immediately.

1.06 INFORMATIONAL SUBMITTALS

- A. Site Utilization Plan: Within ten (10) business days after notice to proceed, the General Trades Contractor shall submit a CAD style drawing indicating temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
 - 1. This drawing shall be submitted for review and acceptance by the Government.
 - a. Utilizing the Overall Site Plan Drawing in the construction documents, the General Trades Contractor will notate the locations of all temporary facilities, including office trailers, storage containers, utility hookups, staging areas, temporary restrooms, specialty equipment (i.e. cranes), dumpsters, and parking areas for construction personnel.
 - b. Dimensions reflecting the distances from all temporary facilities items to existing permanent benchmarks (buildings, concrete curbs, etc.) shall be notated. Two (2) dimensions, each from perpendicular cardinal directions (one dimension beginning North-South, one dimension bearing East-West), shall be shown for each temporary facility items to help clarify positioning from permanent benchmarks.
 - c. A narrative to accompany the notated drawing will be required as necessary to support the information on the drawing, including durations and timelines for the use of specialty equipment such as cranes and any potential street closures, and any other construction activities which may affect the operation of the Government, and/or the municipality.
- B. Erosion and Sedimentation Control Plan: Contractors shall follow the erosion and sedimentation control plan as per the location county conservation district or authorities having jurisdiction, whichever is more stringent.

- C. Dust-Control and HVAC-Control Plan: Within ten (10) business days from Notice to Proceed, Contractors requiring the Work shall submit coordination drawing and
 1. narrative that indicates the dust-control and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:
 2. Locations of dust-control partitions at each phase of the work.
 3. HVAC system isolation schematic drawing.
 4. Location of proposed air filtration system discharge.
 5. Other dust-control measures.
 6. Waste management plan.

1.07 QUALITY ASSURANCE

- A. Electric Service: Comply with OSHA, NEC and UL standards and regulations and requirements of authority having jurisdiction for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. Accessible Temporary Egress: Comply with applicable provisions in ADA-ABA Accessibility Guidelines and ANSI A117.1

1.08 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Government's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.01 TEMPORARY FACILITIES

- A. Field Offices: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Stairs: The General Trades Contractor shall provide temporary stairs until permanent stairs are available and where ladders are not adequate

2.02 EQUIPMENT

- A. Fire Extinguishers: General Trades Contractor shall provide hand carried, portable, UL rated, Class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classed for the exposures. Comply with NFPA 10 classification, extinguishing agent and size required by location and class of fire exposure. Provide one (1) fire extinguisher per 10,000 sf of useful floor area upon building being deemed by the Government as "Dry-in".
- B. HVAC Equipment: Unless Government authorizes use of permanent HVAC system, General Trades Contractor shall provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 2. Heating, Cooling, and Dehumidifying Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction and marked for intended location and application.
 3. Permanent HVAC System: If Government authorizes use of permanent HVAC system for temporary use during construction, HVAC Contractor shall be responsible to provide filters with MERV of 8 at each return-air grille in system and remove at end of construction. HVAC Contractor shall clean HVAC system as required in Section 01 77 00 - Closeout Procedures.
- C. Water Hoses

1. Each Contractor shall provide heavy duty, abrasion-resistant, flexible rubber hoses with pressure ratings greater than the maximum pressure of the water distribution system as required for the work of their Contract. Provide adjustable shut off nozzles at hose discharge.
- D. Electrical Outlets
 1. The Electrical Contractor shall provide properly configured polarized outlets to prevent insertion of 110-120V plugs into higher voltage outlets. Provide receptacle equipped with ground fault circuit interrupters, reset buttons, and pilot lights for connection of power tools and equipment.
- E. Electrical Power Cords
 1. Each Contractor shall provide grounded extension cords. Use hard service cords when exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.
- F. Field Documents
 1. Each Contractor must maintain in their field office a copy of all Contract Documents, Change Orders, supplemental drawings, and shop drawings. Each Contractor must also maintain all OSHA standards, SDS sheets, and emergency phone numbers.
- G. Temporary Toilet Units
 1. The General Trades Contractor shall provide self-contained single occupant toilet units of the chemical or aerated recirculation type, properly vented and fully enclosed with a glass fiber reinforced polyester shell or similar non-absorbent material. Provide one (1) unit for every ten (10) workers on the Project. A waterless, disinfectant skin-cleansing agent shall be provided in the immediate vicinity of each toilet unit. Establish and implement a schedule for servicing, cleaning, and supplying each facility; as well as controls to prevent use from unauthorized personnel such as displaced persons and the general public. Contractors are to only use the temporary toilets provided by the General Trades Contractor. Contractor use of public or private restrooms in any part of Government's buildings is prohibited.
- H. First Aid Supplies
 1. Each Contractor shall comply with governing regulations.
- I. Labor Law Postings:
 1. Each Contractor is responsible to provide US Department of Labor, Labor Law and OSHA postings at the jobsite.
- J. Lamps and Light Fixtures:
 1. Electrical Contractor shall provide rough LED fixtures required for adequate illumination. Provide guard cages or tempered glass enclosures, were exposed to breakage. Provide exterior fixtures were exposed to moisture. Lighting and receptacles shall not be on the same circuit.

PART 3 - EXECUTION

3.01 TEMPORARY FACILITIES, GENERAL

- A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

3.02 INSTALLATION, GENERAL

- A. 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.

- B. 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.
- C. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.

3.03 TEMPORARY UTILITY INSTALLATION

- A. General: The Electrical Contractor is to coordinate and install temporary electrical service.
 - 1. Arrange with utility company, and Government for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: The General Trades Contractor is to provide temporary utilities to remove effluent lawfully.
- C. Water Service: Prior to well installation, the General Trades Contractor shall provide temporary water via a temporary storage tank centrally located on site. Tank shall be
 - 1. sized for general usage. Water needed for specific tasks such as concrete or sprinkler testing shall be provided by the Contractor performing the work. After well installation and prior to Substantial Completion, tank may be removed at the General Trades Contractor's discretion.
- D. Sanitary Facilities: The General Trades Contractor is to provide temporary toilets, wash facilities, safety shower and eyewash facilities, and drinking water for use of construction personnel. Facilities shall comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
- E. Temporary Heating, Cooling, Ventilation and Humidity Control: The General Trades Contractor shall provide temporary heating, cooling, ventilation, and humidity control 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. Contractor to select equipment that will not have a harmful effect on completed installations or elements being installed. Contractor shall coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
 - 1. Select safe equipment that will not have a harmful effect on completed installation or elements being installed. Coordinate ventilation requirements to produce the ambient condition required.
 - 2. Except where use of the permanent system is authorized, provide vented, self-contained LP gas or fuel oil heaters with individual space thermostatic control. Provide gas and carbon monoxide detection devices.
 - 3. After the permanent heating and air conditioning system are generally ready for use and the condition of construction requires continuous 24-hour heat in the building, the HVAC Contractor shall provide temporary heat using the permanent heating system. The entire building shall be conditioned so that final finishes can be applied. The General Trades Contractor shall pay for all fuel required to utilize the Mechanical system for providing temporary heat and air conditioning after the Mechanical system is generally ready for use. It shall be the HVAC Contractor's responsibility to ensure that the permanent Mechanical system is generally ready for use within thirty (30) days after equipment start-up for that area as defined in the most current Project schedule. At this time, the temporary heating systems shall be removed upon coordination with the General Trades Contractor and with Government approval.
 - 4. All permanent heating and air conditioning equipment used to supply temporary heat and air conditioning shall be completely cleaned and reconditioned by the HVAC Contractor prior to final acceptance. The Government may elect to inspect all equipment and systems before final acceptance. Install new disposable filters and clean non-disposable filters prior to final acceptance. The one (1) year warranty for permanent heating and air conditioning equipment shall become effective from the date of substantial completion. The HVAC Contractor shall pay charges for extended warranty for use of permanent systems prior to substantial completion.

5. General Trades Contractor shall provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.
- F. Isolation of Work Areas: All Contractors shall prevent dust, fumes, and odors from entering occupied areas.
 1. Prior to commencing work, HVAC Contractor shall isolate the HVAC system in area where work is to be performed in accordance with approved coordination drawings. Including but not limited to:
 - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
 - b. Maintain negative air pressure within work area using HEPA-equipped air filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
 2. General Trades Contractor shall provide and maintain dust partitions between occupied and unoccupied spaces during the Work.
 3. Each Contractor shall use vacuum collection attachments on dust-producing equipment and shall isolate limited work within occupied areas using portable dust containment devices.
 4. Each Contractor shall perform daily construction cleanup and any final cleanup using approved, HEPA-filter-equipped vacuum equipment.
- G. Electric Power Service: The Electrical Contractor shall provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations. Maintain equipment in a condition acceptable to the NEC. Obtain all required permits.
- H. Lighting: The Electrical Contractor shall provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
 2. Install lighting for the Project identification sign (if applicable).
 - a. Temporary Electric Power Distribution:
 3. As soon as Government notifies the Prime Contractors after the start of the work at the project site, the Electrical Contractor shall provide temporary electrical power distribution system as needed to execute the work of this project, sufficient to accommodate temporary lighting and construction operations including the use of power tools, contractors job trailers, but not including startup of specified building equipment which must be tested, started or placed into use prior to completion of permanent power connections. Provide weatherproof, grounded wiring with overload protection, with direct wired connections, where feasible, and for all voltages over 120 volts. Locate multiple outlets, not less than 4 gang at each story of construction, spaced so that entire area of construction can be reached by power tools on a single extension cord of 100' maximum lengths.
 - a. Electrical Contractor shall provide and pay for all installation, maintenance, servicing, operation, and supervision of lines installed unless otherwise noted.
 - b. Electrical Contractor shall provide service with ground fault circuit interrupter feature, activated from each circuit of 20 ampere or less rating.
- I. Temporary Propane or Natural Gas Distribution
 1. If required for the Work of the Contractor, each Contractor shall provide temporary propane or gas distribution systems for completion of the Contractor's Work.
 - a. The Contractor shall pay for all temporary distribution charges.
 - b. Contractor shall provide and pay for all installation, maintenance, servicing, operation and supervision of distribution.

3.04 SUPPORT FACILITIES INSTALLATION

- A. General: Maintain support facilities until Substantial Completion inspection date is scheduled. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to and only with prior authorization from the Government.
- B. Temporary Roads and Paved Areas: The General Trade Contractor shall construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas as indicated on Contract Drawings. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
 - 1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
 - 2. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
 - 3. Prepare subgrade and install subbase and base for temporary roads and paved areas specified in Individual Specification Sections.
 - 4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course.
- C. Traffic Controls: Comply with requirements of authorities having jurisdiction.
 - 1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- D. Parking: General Trades Contractor shall provide temporary onsite parking or Contractor are use designated areas of Owner's existing parking areas as noted in the Contract Documents for construction personnel.
- E. Storage and Staging: General Trades Contractor shall provide temporary onsite staging area or Contractors are to use designated areas of Project site for storage and staging needs as noted in the Contract Documents.
- F. Dewatering Facilities and Drains: The General Contractor shall comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water except as noted below.
 - 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 - 2. Remove snow and ice as required to minimize accumulations.
 - 3. Each Contractor shall be responsible for dewatering excavations associated with their Work.
- G. Waste Disposal Facilities: General Trades Contractor to provide waste-collection containers in sizes adequate to handle waste from construction operations. Disposal shall comply with requirements of authorities having jurisdiction and shall Comply with requirements specified in Section 01 74 19 - Construction Waste Management and Disposal. Hazardous materials shall not be placed in dumpsters. Do not hold materials more than seven (7) days during normal weather or three (3) days when temperatures are expected to rise above 80 degrees Fahrenheit. Handle hazardous, dangerous, or unsanitary water or materials separately from other waste by containerizing properly and disposing of in a lawful manner.
- H. Lifts and Hoists: Each Contractor shall provide facilities necessary for hoisting materials and personnel.
 - 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

3.05 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: General Trades Contractor shall protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent

properties, except those indicated to be removed or altered. Repair damage to existing facilities.

1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.
- B. Environmental Protection: General Trades Contractor shall provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- C. Erosion and Sedimentation Control: If applicable, the General Trades Contractor shall be party to the NPDES (National Pollutant Discharge Elimination System) co-permittee agreement and shall provide and maintain erosion and sedimentation controls for the project, including concrete washout containment devices.
 1. The Contractor shall conduct a pre-installation meeting with the Government, and County Conservation District not less than five (5) business days prior to commencement of work. Document the results of this meeting and submit to the Government.
 2. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, in accordance with erosion- and sedimentation-control Drawings and requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
 - a. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree or plant protection zones.
 - b. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
 - c. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 - d. Inspect, repair, and maintain Erosion and Sedimentation controls during construction.
 - 1) Inspect all Erosion and Sedimentation controls not less than every seven (7) days or as noted on the Contract Documents, and after each occurrence of a storm event.
 - e. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- D. Rock Construction Entrance: The General Trades Contractor shall provide and maintain the rock construction entrance, temporary roads, and paved areas in accordance with the Contract Documents or as necessary for execution of the Work.
- E. Vegetation Control: The General Trades Contractor shall provide mowing and maintenance of lawns within the construction areas as required by the Specifications until Substantial Completion of the Project. This includes vegetation control throughout the entire site during construction.
- F. Drives and Aisles Maintenance: The General Trades Contractor shall provide sweeping, cleaning, and snow removal of all drives, parking lots, and roadways throughout the duration of the Project.
- G. Tree and Plant Protection: General Trades Contractor shall 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.
- H. Pest Control: General Trades Contractor shall engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.

- I. Site Enclosure Fence: Before construction operations begin the General Trades Contractor shall furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates. Provide minimum 2-inch OD, 11-1/2-gauge, galvanized steel, with top, middle, and bottom pipe rails, stands, hardware and fittings. Fencing shall be a minimum height of 8'-0". Bases of stands shall be weighted as required to keep fence panels upright. Provide a minimum of two, twenty-foot-wide gated openings for vehicle access. Vehicle gates shall include rolling casters for gate swings and hardware for locking mechanisms. Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
 - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations or As indicated on Drawings.
 - 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to the Government.
 - 3. Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.
- J. Barricades, Warning Signs, and Lights: The General Trades Contractor shall comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- K. Temporary Enclosures: The General Trades Contractor shall 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.
 - 1. Where heating or cooling is needed and permanent enclosure is incomplete, the General Trades Contractor shall insulate temporary enclosures.
- L. Temporary Partitions: The General Trades Contractor shall Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Government and/or tenants from fumes and noise.
 - 1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
 - 2. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
 - 3. Insulate partitions to control noise transmission to occupied areas.
 - 4. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
 - 5. Protect air-handling equipment.
 - 6. Provide walk-off mats at each entrance through temporary partition.
- M. Covered Walkway: When working in or adjacent to occupied buildings, the General Trades Contractor is to erect protective, covered walkway for passage of individuals through or adjacent to Project site. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction.
 - 1. Construct covered walkways using scaffold or shoring framing.
 - 2. Provide overhead decking, protective enclosure walls, handrails, barricades, warning signs, exit signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
- N. Fire Safety During Construction: All Contractors shall comply with all requirements identified herein as well as the more stringent requirements of the applicable codes (State Building and Fire Codes or Local Building and Fire Codes and including NFPA 241; manage fire-prevention program.)
 - 1. No smoking: Smoking and vaping shall be prohibited throughout the project/construction site. "No Smoking/No Vaping" signs shall be conspicuously provided and installed by the General Trades Contractor at all entrances and throughout the site.

2. Each Contractor shall designate a Fire Prevention Program Superintendent/ Fire Safety Manager who shall be responsible for all fire safety efforts of Contractor's Work until completion and acceptance of the Work described in the Contract Documents that include but are not limited to the following:
 - a. Pre-Fire Plans. Develop in cooperation with the local Fire Chief and Fire Code Official. Any changes affecting the utilization of information contained in the plan shall result in notification to the local Fire Chief and Fire Code Official.
 - b. Training. Job site personnel shall be trained in fire safety practices and procedures and the proper use of fire protection equipment, including hand-held fire extinguishers, hose lines, fire alarm and sprinkler systems.
 - c. Fire Protection Devices. Fire protection and detection equipment shall be maintained and serviced.
 - d. Hot Work Operations. Welding, cutting, open torches, torch-applied roof system activities, and other hot work operations shall be conducted under a permit system. A fire watch and fire extinguishers shall be provided.
 - e. Impairment of Fire Protection Systems. Coordinate planned, emergency or accidental impairments of fire protection systems to include tagging of impaired systems and notification of Fire Department, Alarm Company, Government, and Contractors.
 - f. Temporary Covering of Fire Protection Devices. Coverings placed on or over fire protection devices for protection from damage shall be immediately removed upon the completion of the Work in the room or area in which the devices are installed.
3. Plumbing Contractor shall 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.

3.06 MOISTURE AND MOLD CONTROL

- A. Moisture and Mold Protection: All Contractors shall protect their stored materials and installed Work.
- B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, all Contractors shall protect their Work as follows:
 1. Protect porous materials from water damage.
 2. Protect stored and installed material from flowing or standing water.
 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 4. Remove standing water from decks.
 5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, all Contractors shall protect their Work as follows:
 1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 2. Keep interior spaces reasonably clean and protected from water damage.
 3. Periodically collect and remove waste containing cellulose or other organic matter.
 4. Discard or replace water-damaged material.
 5. Do not install material that is wet.
 6. Discard and replace stored or installed material that begins to grow mold.
 7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.
- D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, the General Trades Contractor shall maintain conditions as follows:
 1. Control moisture and humidity inside building by maintaining effective dry-in conditions.

2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
 - a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective.
 - b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record daily readings over a 48-hour period. Identify materials containing moisture levels higher than allowed. Report findings in writing to the Government. Remove and replace materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.07 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: All Contractors shall enforce strict discipline in use of temporary facilities to minimize waste and abuse. Contractors shall limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Installing Contractor shall maintain facilities in good operating condition until removal.
 1. 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.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Installing Contractor shall remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 1. Materials and facilities that constitute temporary facilities are property of Contractor.
 2. General Contractor shall remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. 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.
 3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 77 00 - Closeout Procedures.

END OF SECTION

**SECTION 01 60 00
PRODUCT REQUIREMENTS**

PART 1 - GENERAL**1.01 SUMMARY**

- A. The Work of This Section Includes: Administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

1.02 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
 2. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products unless otherwise indicated.
 3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in "Comparable Products" Article, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of- design product " including make or model number or other designation. to establish the significant qualities
1. related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.
- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, Contractor shall submit to Government another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.

1.03 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
 2. Designer's Action: If necessary, Government will request additional information or documentation for evaluation within seven (7) calendar days of receipt of a comparable product request. Government will notify Contractor of approval or rejection of proposed comparable product request within fifteen (15) business days of receipt of request, or five (5) business days of receipt of additional information or documentation, whichever is later.
 - a. Form of Approval: As specified in Section 01 33 00 - Submittal Procedures.
 - b. Use product specified if Government does not issue a decision on use of a comparable product request within time allocated.

- B. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 01 33 00 - Submittal Procedures.
- C. Substitution: Refer to Section 01 2 500 - Substitution Procedures for definition and limitations on substitutions.

1.04 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
 - 1. Resolution of Compatibility Disputes between Multiple Contractors
 - a. Each Contractor is responsible for providing products and construction methods compatible with products and construction methods of other Contractors.
 - b. If a dispute arises between Contractors over concurrently selectable but incompatible products, Government will determine which products shall be used.
- B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.
 - 1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
 - 2. Equipment Nameplates: Provide a permanent nameplate on each item of service- or power- operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:
 - a. Name of product and manufacturer.
 - b. Model and serial number.
 - c. Capacity.
 - d. Speed.
 - e. Ratings.
 - 3. See individual identification Sections in Divisions 21, 22, 23, and 26 for additional equipment identification requirements.

1.05 COORDINATION

- A. Modify or adjust affected work as necessary to integrate work of approved comparable products and approved substitutions.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products, using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling
 - 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 - 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
 - 1. Store products to allow for inspection and measurement of quantity or counting of units.
 - 2. Store materials in a manner that will not endanger Project structure.

3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.
7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Government.

1.07 PRODUCT WARRANTIES

- A. Warranties specified in other Sections are to be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 1. Manufacturer's Warranty: Written standard warranty form furnished by individual manufacturer for a particular product and issued in the name of Government or endorsed by manufacturer to Government.
 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Government and issued in the name of Government or endorsed by manufacturer to Government.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 01 77 00 - Closeout Procedures.

PART 2 - PRODUCTS

2.01 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Government reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Government will make selection.
 5. Descriptive, performance, and reference standard requirements in Specifications establish salient characteristics of products.
 6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
 - a. Submit additional documentation required by Designer through Government to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by the Government, whose determination is final.
- B. Product Selection Procedures:

1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."
 2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."
 3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."
 4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed or an unnamed product that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.
 - a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."
 - b. Provision of an unnamed product is not considered a substitution if the product complies with requirements.
 5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."
 6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed or a product by an unnamed manufacturer that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.
 - a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following."
 - b. Provision of products of an unnamed manufacturer is not considered a substitution if the product complies with requirements.
 7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
 - a. For approval of products by unnamed manufacturers, comply with requirements in Section 01 25 00 - Substitution Procedures for substitutions for convenience.
- C. Visual Matching Specification: Where Specifications require the phrase "match Government's sample," provide a product that complies with requirements and matches Government's sample. Government's decision will be final on whether a proposed product matches.

1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 01 25 00 - Substitution Procedures for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Designer from manufacturer's full range" or a similar phrase, select a product that complies with requirements. Government will select color, gloss, pattern, density, or texture from manufacturer's product line.

2.02 COMPARABLE PRODUCTS

- A. Conditions for Consideration of Comparable Products: Designer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Government may return requests without action, except to record noncompliance with the following requirements:
 1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. Significant product qualities include attributes, such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects, with project names and addresses and names and addresses of Designer and Owners, if requested.
 5. Samples, if requested.
- B. Designer's Action on Comparable Products Submittal: If necessary, Government will request additional information or documentation for evaluation within seven (7) calendar days of receipt of a request for a comparable product. Government will notify Contractor of approval or rejection of proposed comparable product within fifteen (15) business days of receipt of request, or five (5) business days of receipt of additional information or documentation, whichever is later.
 1. Government's Approval of Submittal: As specified in Section 01 33 00 - Submittal Procedures.
 2. Use product specified if Government does not issue a decision on use of a comparable product request within time allocated.
- C. Submittal Requirements, Two-Step Process: Approval by Government of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

END OF SECTION

**SECTION 01 73 00
EXECUTION****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section. The requirements of this Section apply to all Contractors unless otherwise noted.

1.02 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering.
 - 3. Installation.
 - 4. Cutting and patching.
 - 5. Coordination of Owner's portion of the Work. (if applicable)
 - 6. Progress cleaning.
 - 7. Starting and adjusting.
 - 8. Protection of installed construction.
 - 9. Correction of the Work.

1.03 REFERENCE STANDARDS

- A. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.

1.04 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Land Surveyor and/or Professional Engineer.
- B. Certificates: Submit certificate signed by land surveyor and/or professional engineer, certifying that location and elevation of improvements comply with requirements.
- C. Cutting and Patching Plan: Each Contractor for their work shall submit plan describing procedures at least 48 hours prior to the time cutting and patching will be performed. Include the following information:
 - 1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
 - 2. Changes to in-place construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in appearance and other significant visual elements.
 - 3. Products: List products to be used for patching and firms or entities that will perform patching work.
 - 4. Dates: Indicate when cutting and patching will be performed.
 - 5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
 - a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.
- D. Landfill Receipts: Submit copy of receipts issued by landfill facility, licensed to accept contaminated or hazardous materials, for disposal of such materials.

1.06 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
 - 1. Structural Elements: When cutting and patching structural elements, or when encountering the need for cutting and patching of elements whose structural function is not known, the Contractor will engage an engineer certified in the state where the work is taking place and provide signed and sealed drawings and calculations of proposed means and methods for review by the Designer before proceeding. Shore, brace, and support structural elements during cutting and patching per the reviewed plan. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
 - 2. 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. Operational elements include, but are not limited to, the following:
 - a. Primary operational systems and equipment.
 - b. Control systems.
 - c. Communication systems.
 - d. Electrical wiring systems.
 - e. Operating systems of special construction.
 - 3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity or reduce system performance, or that results in increased maintenance or decreased operational life, impacts to existing warranties or safety. Other construction elements include, but are not limited to, the following:
 - a. Water, moisture or vapor barriers.
 - b. Membranes and flashings.
 - c. Equipment supports.
 - 4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Designer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- C. Cutting and Patching Conference: Before proceeding, meet with parties involved in cutting and patching including the Government and other appropriate agencies. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.
- D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Comply with requirements specified in other Sections.
 - 1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with sustainable design requirements.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to the Government for the visual and functional performance of in-place materials. Use materials that are not considered hazardous.

- C. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning any excavation, Contractor shall investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
 - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, and water-service piping; underground electrical services; and other utilities.
 - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations. Each Contractor shall be responsible for examination and acceptance of conditions related to installations of their respective Work.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - 1. Description of the Work, including Specification Section number and paragraph, and Drawing sheet number and detail, where applicable.
 - 2. List of detrimental conditions, including substrates.
 - 3. List of unacceptable installation tolerances.
 - 4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Existing Utility Information: Furnish information to Government that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Contractor's Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a Request for Information to Government in accordance with requirements in Section 01 31 00 - Project Management and Coordination.
- E. Contractor must give notice to the Government no less than 48 hours prior regarding construction activities that will possibly affect their daily operations.

3.03 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, General Trades Contractor shall verify layout information shown on Drawings, in relation to the property survey and existing benchmarks and existing conditions. If discrepancies are discovered, notify Government promptly.
- B. Engage a land surveyor or professional engineer experienced in laying out the Work, using the following accepted surveying practices:
 - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 - 2. Establish limits on use of Project site.
 - 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 - 4. Inform installers of lines and levels to which they must comply.
 - 5. Check the location, level and plumb, of every major element as the Work progresses.
 - 6. Notify Government when deviations from required lines and levels exceed allowable tolerances.
 - 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations. At Project Completion, provide locations and depths of underground and underslab utilities, including point locations every 100' and or change in direction or elevation.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Government.

3.04 FIELD ENGINEERING.

- A. Identification: Contract Document will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Each Contractor shall take efforts to Preserve and protect permanent benchmarks and control points during construction operations.
 - 1. Do not change or relocate existing benchmarks or control points without prior written approval of the Government. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to the Government before proceeding.
 - 2. Offending Contractor shall Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of two (2) permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
 - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 - 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 - 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

- D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- E. As-Built Surveys of Stormwater Management Facilities: The General Trades Contractor shall engage a Land Surveyor to prepare as-built surveys of all Stormwater Management Facilities, including drainage pipes and structures, rain gardens, subsurface infiltration facilities, vegetative swales and detention basins.

3.05 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure satisfactory results as judged by the Government. Maintain conditions required for product performance until Substantial Completion.
- D. Preparation for and the installation of physical work-in-place of work described herein these Construction Documents may not commence until the Commencement of Physical Work date.
- E. Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.
- F. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.
- G. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.
- H. Templates: Obtain and distribute to the parties' involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- I. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer. Each Contractor to coordinate attachment requirements of their Work as it relates to Work of the other Contractors.
 - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Government.
 - 2. Allow for building movement, including thermal expansion and contraction.
 - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, which are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation by the General Trades Contractor.
- J. Hazardous Materials: Use products, cleaners and installation materials that are not considered hazardous.

3.06 CUTTING AND PATCHING

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. 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.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of Work to be cut.
- D. 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.
- E. 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 interruption.
- F. 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.
 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporary cover openings when not in use.
 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 5. 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.
 6. Proceed with patching after construction operations requiring cutting are complete.
- G. 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 practicable, as judged by Government. Provide materials and comply with installation requirements specified in other Sections, where applicable. Where patching is required by Contractor in Work that will receive finishes installed by another Contractor, patching Contractor to prepare substrate surfaces suitable for finish applications of other Contractor.
 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 2. 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.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 3. 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.
 - a. Where patching occurs in a painted surface, prepare substrate, apply primer, and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch, corner of wall and edge to edge of ceiling. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- H. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.07 COORDINATION OF OWNER'S PORTION OF THE WORK

- A. Site Access: When required, provide access to Project site for Government's personnel and Owner's separate Contractors.
1. Provide temporary facilities required for Government-furnished, Contractor-installed products.
 2. Refer to Section 01 10 00 - Summary for other requirements for Government-furnished, Contractor-installed products
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel and Owner's separate contractors.
1. Construction Schedule: Inform Government of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Government if changes to schedule are required due to differences in actual construction progress.

3.08 PROGRESS CLEANING

- A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven (7) days during normal weather or three (3) days if the temperature is expected to rise above 80 degrees Fahrenheit.
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, in accordance with regulations.
 - a. Use containers intended for holding waste materials of type to be stored.
 4. Coordinate progress cleaning for joint-use areas where Contractor and other Contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces in accordance with written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 01 74 19 - Construction Waste Management and Disposal.

- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.
- K. Asbestos Remediation: Work must be performed as required per local, state laws and regulations.

3.09 STARTING AND ADJUSTING

- A. Coordinate startup and adjusting of equipment and operating components with Plumbing, Mechanical and Electrical Specification Sections.
- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00 - Quality Requirements.

3.10 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.
- C. Comply with manufacturer's written instructions for temperature and relative humidity.

3.11 CORRECTION OF THE WORK

- A. Offending Contractor shall be responsible for cost to repair or remove and replace damaged, defective, or nonconforming Work. Restore damaged substrates and finishes.
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.
- C. Restore permanent facilities used during construction to their specified condition.
- D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION

**SECTION 01 74 19
CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL**

PART 1 - GENERAL**1.01 SUMMARY**

- A. Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous demolition and construction waste.
 - 2. Recycling nonhazardous demolition and construction waste.
 - 3. Disposing of nonhazardous demolition and construction waste.

1.02 DEFINITIONS

- A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.
- C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner's property.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.03 ACTION SUBMITTALS

- A. Waste Management Plan: General Trade Contractor shall Submit the Waste Management Plan within seven (7) business days from Notice to Proceed.

1.04 INFORMATIONAL SUBMITTALS

- A. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- B. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
- C. 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.
- D. 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.

1.05 PERFORMANCE REQUIREMENTS

- A. Recycle Requirements: Where possible, recycle nonhazardous demolition waste including but not limited to the following materials: steel, aluminum, copper, brick, glass, plastic, florescent light bulbs.

1.06 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

1.07 WASTE MANAGEMENT PLAN

- A. General: Develop plan consisting of waste identification.

- B. Waste Identification: Indicate anticipated types of demolition and construction waste generated by the Work.
- C. Waste Management Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator.
 - 1. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
 - 2. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
 - 3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
 - 4. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
 - 1. Comply with Section 01 50 00 - Temporary Facilities and Controls for operation, termination, and removal requirements.
- B. Waste Management Coordinator: General Trades Contractor shall assign a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan for full duration of Project.
- C. Training: Train General Trades Contractor shall train Contractors, workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
 - 1. Distribute waste management plan to everyone concerned within three (3) business days of submittal return.
 - 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- D. 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.
 - 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated or sold.
 - 2. Comply with Section 01 50 00 - Temporary Facilities and Controls for controlling dust and dirt, environmental protection, and noise control.

3.02 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall be shared equally by Government and Contractor.
- C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.
- D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved Construction Waste Management Plan.
 - 1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

- a. Inspect containers and bins for contamination and remove contaminated materials if found.
2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.03 RECYCLING CONSTRUCTION WASTE

- A. Packaging:
 1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
 2. 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.
 3. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

3.04 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials.
 1. Disposal: General Trades Contractor shall legally transport and dispose of all waste materials off Owner's property. Contractor responsible for all fees, permits, etc. required to receive waste materials.

END OF SECTION

**SECTION 01 77 00
CLOSEOUT PROCEDURES**

PART 1 - GENERAL**1.01 SUMMARY**

- A. Section includes administrative and procedural requirements for Contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final Completion procedures.
 - 3. List of incomplete items.
 - 4. Submittal of Project warranties.
 - 5. Final cleaning.
 - 6. Repair of the Work.
 - 7. As-Built Surveys.

1.02 ACTION SUBMITTALS

- A. Contractor's Punchlist: Initial outstanding work submittal at Substantial Completion
- B. Closeout Checklist: At a minimum of sixty (60) days prior to Substantial Completion, the Government will endeavor to provide each Prime Contractor with a list of outstanding Closeout Submittals as enumerated in Section 1.5 below.

1.03 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. Maintenance Bond.
- D. Contractor Affidavit of Payment of Debts and Claims.
- E. Contractor Affidavit of Release of Liens.
- F. Consent of Surety to Final Payment.
- G. Confirmation of Completed Punchlist.
- H. Final Application for Payment.
- I. Record Drawings.
- J. Operations and Maintenance Manuals.
- K. Warranties.
- L. Attic Stock.
- M. ST Forms.
- N. Contractor Daily Reports.
- O. Government Demonstration and Training.
- P. Field Report: For pest-control inspection.

1.04 SUBSTANTIAL COMPLETION PROCEDURES

- A. Outstanding Items List: At a minimum of no less than thirty (30) days prior to the project's established Substantial Completion date, the Contractor shall provide a list of outstanding work to be completed.
- B. Contractor's List of Incomplete Items: Upon receipt of each Contractor's Outstanding Items List the Government will schedule a time with the Contractor to review their Outstanding Items List on site. During this site review, the Government may add to the Contractor's Outstanding Item List, additional incomplete or non-conforming work items. This updated Outstanding Items List will become the Contractor's official Punch List. The Government will then distribute the Punch

List to the Contractor for their use in completing these activities by the Final Completion date of the Project.

- C. Substantial Completion Certificate: Each Contractor shall request in writing to the Government, that their portion of the project is substantially complete. Each Prime Contractor's written request is to be issued to the Government no later than the Project substantial completion date. This letter shall bare witness that this Contractor's portion of work is complete to the extent that beneficial use or occupancy by the Government could occur. Upon receipt of this request, the Government, shall inspect the work to determine if the Contractor's work is complete sufficient to allow for beneficial use and occupancy of the facility.
 - 1. Contractual Items for Substantial Completion:
 - a. Final cleaning.
 - b. Testing and startup of systems and equipment.
 - c. Maintenance on permanent equipment used during construction.
 - d. Demonstration and Training
- D. Turnover Notifications: Each Contractor shall complete prior to the date of Substantial Completion the following items:
 - 1. Advise the Government of pending insurance changeover requirements.
 - 2. Advise the Government's personnel of changeover in security provisions.
 - 3. Advise Government of changeover in utilities.

1.05 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, each Contractor shall complete the following:
 - 1. Submit a final Application for Payment in accordance with Section 01 29 00 Payment Procedures.
 - 2. Certified List of Incomplete Items: Submit certified copy of Government's Substantial Completion inspection list of items to be completed or corrected (Punch List). Certified copy of the list will state that each item has been completed or otherwise resolved for acceptance.
 - 3. Removal of Temporary Facilities and Utilities, including but not limited to, construction trailers, laydown area, job boxes, etc. Provide the patching, repair and or painting as a result of their removal.
 - 4. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of ten (10) business days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Government will either proceed with inspection or notify Contractor of unfulfilled requirements. Government will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1.06 SUBMITTAL OF PROJECT WARRANTIES AND OPERATIONAL AND MAINTENANCE MANUALS

- A. Time of Submittal: Submit written warranties on request of Government for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Government's rights under warranty.
- B. Operation and Maintenance Manuals and Warranty documents: Organize into an orderly sequence based on the table of contents of the Project Manual.
 - 1. Electronic File: Assemble complete binders containing Operation and Maintenance Manuals, Warranties and Bonds into a single, indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at the beginning of the document.

2. The HVAC Contractor shall be the O&M/Warranty Coordinator for this project. Reference Specification Section 01 31 00 - Project Management and Coordination.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.01 FINAL CLEANING

- A. General Trades Contractor shall Perform final cleaning. Conduct cleaning and waste- removal operations to comply with local laws and ordinances and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Clean Project site of rubbish, waste material, litter, and other foreign substances.
 - b. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - c. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - d. Clean flooring, removing debris, dirt, and staining; clean in accordance with manufacturer's instructions.
 - e. Vacuum and mop concrete.
 - f. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean in accordance with manufacturer's instructions if visible soil or stains remain.
 - g. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision- obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - h. Remove labels that are not permanent.
 - i. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - j. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - k. HVAC Contractor shall replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - l. HVAC Contractor shall Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
 - m. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
 - n. Clean strainers.
 - o. Leave Project clean and ready for occupancy.
- C. Pest Control: Comply with pest control requirements in Section 01 50 00 - Temporary Facilities and Controls. Prepare written report.
- D. Construction Waste Disposal: Comply with waste-disposal requirements in Section 01 74 19 - Construction Waste Management and Disposal.

3.02 CORRECTION OF THE WORK

- A. Complete repair and restoration operations required by "Correction of the Work" Article in Section 01 73 00 - Execution before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repair includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials and properly adjusting operating equipment. Where damaged or work items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to the specified condition.
 - 1. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
 - 2. exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
 - 3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.

END OF SECTION

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL**1.01 SUMMARY**

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and Maintenance Manuals
 - 2. Product Manuals

1.02 DEFINITIONS

- A. System: An organized collection of parts, equipment or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.03 COORDINATION

- A. As the Coordinating Contractor, the General Trades Contractor will serve as the coordinator for submission of Operation and Maintenance Manuals. Each Contractor shall compile documentation as per the requirements of this section and submit to the General Trades Contractor. General Trades Contractor shall compile provided information and submit a complete packet to the Government for review.

1.04 CLOSEOUT SUBMITTALS

- A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections. Submit manual content to correspond to revisions and field conditions.
- B. Format: Submit operations and maintenance manuals in the following format:
 - 1. PDF electronic copy. Assemble each manual into a composite electronically indexed file.
 - a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
 - b. Enable inserted reviewer comments on draft submissions.
- C. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least fifteen (15) business days before commencing demonstration and training.
 - 1. Correct or revise each manual to comply with Government's comments. Submit copies of each corrected manual within fifteen (15) business days of receipt of Government's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS**2.01 OPERATIONS AND MAINTENANCE DOCUMENTATION DIRECTORY**

- A. Directory: Prepare a single, comprehensive directory of operation and maintenance data and materials which list items and their locations to facilitate ready access to desired information. Include a section in the directory for each of the following:
 - 1. List of documents.
 - 2. List of systems.
 - 3. List of equipment.
 - 4. Table of contents.
- B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
- C. List of equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of a system, list alphabetically in a separate list.
- D. Table of Contents: Include a table of contents for each operation and maintenance manual.

- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem and piece of equipment with the same designation used in the Contract Documents.

2.02 REQUIREMENTS FOR OPERATION AND MAINTENANCE MANUALS

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of
 - 1. equipment not part of a section. Each manual shall contain the following materials, in the order listed:
 - 2. Title page.
 - 3. Table of contents.
 - 4. Manual contents.
- B. Title Page: Include the following information:
 - 1. Subject matter included in manual.
 - 2. Name and address of Project.
 - 3. Date of Submittal.
 - 4. Name and contact information for Contractor.
 - 5. Name and contact information for Government.
 - 6. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume and cross-referenced to a Specification Section number in the Contract Documents.
 - 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem and equipment. If possible, assemble instructions for subsystems, equipment and components of one system into a single binder.
- E. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by the manufacturer, where available.
 - 2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual.

2.03 OPERATION MANUALS

- A. Content: Include operation data required in individual Specification Sections in addition to the below requirements:
 - 1. System, subsystem and equipment descriptions. Use designations for systems and equipment indicated in the Contract Documents.
 - 2. Performance and design criteria if Contractor has delegated design responsibility.
 - 3. Operating standards.
 - 4. Operating procedures.
 - 5. Operating logs.
 - 6. Wiring diagrams.
 - 7. Control diagrams.
 - 8. Piped system diagrams.
 - 9. Precautions against improper use.
 - 10. License requirements including inspection and renewal dates.
- B. Descriptions: Include the following:
 - 1. Product name and model number. Use designations for products indicated in the Contract Documents.

2. Manufacturer's name.
 3. Serial number of each component.
 4. Equipment function.
 5. Operating characteristics.
 6. Limiting conditions.
 7. Performance curves.
 8. Engineering data and tests.
 9. Complete nomenclature and number of replacement parts.
- C. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
 2. Equipment or system break-in procedures.
 3. Routine and normal operating instructions.
 4. Regulation and control procedures.
 5. Instructions on stopping.
 6. Normal shutdown instructions.
 7. Seasonal and weekend operating instructions.
 8. Required sequences for electric or electronic systems.
 9. Special operating instructions and procedures.
- D. Systems and Equipment Controls: Describe the sequence of operation and diagram controls as installed.
- E. Piped Systems: Diagram piping as installed and identify color-coding where required for identification.

2.04 PRODUCT MAINTENANCE MANUALS

- A. Content: Organize manual into a separate section for each product, material and finish. Include source information, product information, maintenance procedures, repair materials, repair material sources, warranties and bonds as described below.
- B. Source Information: List each product included in the manual, identified by product name and arranged to match the manual's table of contents. For each product, list
1. name, address and telephone number of installer or supplier and maintenance service agent and cross-reference Specification Section number and title in the Project Manual and the drawing or schedule designation or identifier, where applicable.
- C. Product Information: Include the following, as applicable:
1. Product name and model number.
 2. Manufacturer's name.
 3. Color, pattern and texture.
 4. Material and chemical composition.
 5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
1. Inspection procedures.
 2. Types of cleaning agents to be used and methods of cleaning.
 3. List of cleaning agents and methods of cleaning detrimental to the product.
 4. Schedule for routine cleaning and maintenance.
 5. Repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.

2.05 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Content: For each system, subsystem and piece of equipment not part of a system, include source information, manufacturer's maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts and warranty and bond information as described below.
- B. Source Information: List each system, subsystem and piece of equipment included in the manual, identified by product name and arranged to match the manual's table of contents. For each product, list name, address and telephone number of installer or supplier and maintenance service agent and cross-reference Specification Section number and title in the Project Manual and the drawing or schedule designation or identifier, where applicable.
- C. Manufacturer's Maintenance Documentation: Manufacturer's maintenance documentation including the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins.
 - 2. Drawings, diagrams and instructions required for maintenance, including disassembly and component removal, replacement and assembly.
 - 3. Identification of nomenclature of parts and components.
 - 4. List of items recommended to be stocked as spare parts.
- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - 1. Test and inspection instructions.
 - 2. Troubleshooting guide.
 - 3. Precautions against improper maintenance.
 - 4. Disassembly, component removal, repair, replacement and reassembly instructions.
 - 5. Instructions for aligning, adjusting and checking.
 - 6. Demonstration and training video recording, if applicable.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment and separate schedules for preventative and routing maintenance and service with standard time allotment.
 - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semi-annual and annual frequencies.
 - 2. Maintenance and Service Record: Include manufacturer's forms for recording maintenance.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturer's maintenance documentation with local sources of maintenance materials and related services.
- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.01 MANUAL PREPARATION

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to operation and maintenance manuals.
- B. Product Maintenance Manual: Assemble a complete set of maintenance data including care and maintenance of each product, material and finish incorporated into the Work.
- C. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem and piece of equipment not part of a system.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem and piece of equipment not part of a system.
 2. Prepare a separate manual for each system and subsystem in the form of an instructional manual for use by the Government's operating personnel.
- D. Manufacturer's Data: Where manuals contain manufacturer's standard printed data, include only sheets pertinent to the product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data includes more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
- E. Drawings: Prepare drawings supplanting the manufacturer's printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
1. Do not use original project record documents as part of operation and maintenance manuals.
 2. Comply with requirements of newly prepared record Drawings in Section 01 78 39 - Project Record Documents.

END OF SECTION

**SECTION 01 78 39
PROJECT RECORD DOCUMENTS**

PART 1 - GENERAL**1.01 SUMMARY**

- A. Section includes administrative and procedural requirements for Project Record Documents, including the following:
 - 1. Record Drawings.
 - 2. Miscellaneous Record Submittals.

1.02 CLOSEOUT SUBMITTALS

- A. Record Drawings: All Contractors shall maintain record drawings of their Work and coordinate efforts to maintain and submit, prior to final completion, one paper-copy set of marked-up Record Drawings. As the Coordinating Contractor, the General Trades Contractor shall be responsible for compiling Record Drawings from all Contractors for submission of a final consolidated set. Record Drawings shall comply with the following:
 - 1. Submittal Procedures:
 - a. Each Contractor to maintain one (1) paper copy of marked up Record Drawings.
 - b. Each Contractor to submit to the Coordinating Contractor a scanned PDF electronic file of their Record Drawings.
 - c. Coordinating Contractor to compile and submit one (1) complete set of Record Drawings to the Government for review.
 - d. Government will review and approve Record Drawings.
- B. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities.

1.03 RECORD DRAWINGS

- A. Record Drawings: Each Contractor shall maintain one (1) set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 - 1. Preparation: Mark record prints to show the actual installation, where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations.
 - d. Locations and depths of underground and underslab utilities, including point locations every 100' and or change in direction or elevation.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Government's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.

- n. Record information on the Work that is shown only schematically.
- 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
- 4. Mark record prints with other colors to distinguish between changes for different categories of the Work at same location.
- 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
- 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- 7. Format: Identify each Record Drawing: Include the designation "PROJECT RECORD DRAWING" in a prominent location.
 - a. Format: Annotated PDF electronic file with comment function enabled.
 - b. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each Division of the Contract Drawings. Name each file with the Division identification. Include identification in each digital data file as follows:
 - 1) Project name.
 - 2) Designation "PROJECT RECORD DRAWINGS."
 - 3) Division Identification.
- B. Each Contractor to submit to the Coordinating Contractor a scanned PDF electronic file of their Record Drawings.
- C. Coordinating Contractor to compile and submit one (1) complete set of Record Drawings to the Government for review.
- D. Government will review and approve Record Drawings.

1.04 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
- B. Format: Submit miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

1.05 MAINTENANCE OF RECORD DOCUMENTS

- A. Maintenance and Record Documents and Samples: Store Record Documents and Samples in the Field Office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project Record Documents for Government's reference.

END OF SECTION

**SECTION 01 79 00
DEMONSTRATION AND TRAINING**

PART 1 GENERAL**1.01 SUMMARY**

- A. Section includes administrative and procedural requirements for instructing Government's personnel, including the following:
 - 1. Instruction in operation and maintenance of systems, subsystems, and equipment.
 - 2. Demonstration and training video recordings (as applicable).

1.02 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit within seven (7) calendar days of end of each training module:
 - 1. Attendance Record including name of instructor, date, location, list of participants and length of instruction time.
 - 2. Electronic file or access to recording of onsite demonstration and training or access to manufacturer's authorized training videos.

1.03 QUALITY ASSURANCE

- A. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 01 40 00 - Quality Requirements, experienced in operation and maintenance procedures and training.

1.04 COORDINATION

- A. Coordinate instruction schedule with Government's operations. Adjust schedule as required to minimize disrupting Government's operations and to ensure availability of Government's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals as specified in Section 01 78 23 - Operation and Maintenance Data. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Designer.

END OF SECTION

SECTION 01 91 13
GENERAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL**1.01 SUMMARY**

- A. Commissioning is intended to achieve the following specific objectives; this section specifies the Contractor's responsibilities for commissioning:
 - 1. Verify that the work is installed in accordance with Contract Documents and the manufacturer's recommendations and instructions, and that it receives adequate operational checkout prior to startup: Startup reports and Prefunctional Checklists executed by Contractor are utilized to achieve this.
 - 2. Verify and document that functional performance is in accordance with Contract Documents: Functional Tests executed by Contractor and witnessed by the Commissioning Authority are utilized to achieve this.
 - 3. Verify that operation and maintenance manuals submitted to Government are complete: Detailed operation and maintenance (O&M) data submittals by Contractor are utilized to achieve this.
 - 4. Verify that the Government's operating personnel are adequately trained: Formal training conducted by Contractor is utilized to achieve this.
- B. Commissioning, including Functional Tests, O&M documentation review, and training, is to occur after startup and initial checkout and be completed before Substantial Completion.
- C. The Commissioning Authority directs and coordinates all commissioning activities; this section describes some but not all of the Commissioning Authority's responsibilities.
- D. The Commissioning Authority is employed by Government.

1.02 SCOPE OF COMMISSIONING

- A. The following are to be commissioned:
- B. Building envelope:
 - 1. Air tightness.
- C. Plumbing Systems:
 - 1. Water heaters.
 - 2. Booster pumps.
- D. HVAC System, including:
 - 1. Major and minor equipment items.
 - 2. Piping systems and equipment.
 - 3. Ductwork and accessories.
 - 4. Terminal units.
 - 5. Control system.
- E. Electrical Systems, Including:
 - 1. Lighting Controls: Interio and exterior, automatic and manual daylighting controls, occupancy sensing devices, automatic shut-off controls, and other lighting and dimming controls.
 - 2. Power Dtribtion Panels
- F. Building Envelope Inspection
- G. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.
- H. Indoor Air Quality Procedures: The Commissioning Authority will coordinate; Contractor will execute; see Section 01 57 19 - Temporary Environmental Controls.

1.03 REFERENCE STANDARDS

- A. ASTM E1827 - Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door.
- B. PEI (Samples) - Sample Forms for Prefunctional Checklists and Functional Performance Tests.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures; except:
 - 1. Make all submittals specified in this section, and elsewhere where indicated for commissioning purposes, directly to the Commissioning Authority, unless they require review by Contracting Officer or Contracting Officer's Representative; in that case, submit to Contracting Officer or Contracting Officer's Representative first.
 - 2. Submit one copy to the Commissioning Authority, not to be returned.
 - 3. Make commissioning submittals on time schedule specified by Commissioning Authority.
 - 4. Submittals indicated as "Draft" are intended for the use of the Commissioning Authority in preparation of Prefunctional Checklists or Functional Test requirements; submit in editable electronic format, Microsoft Word 2010 preferred.
 - 5. As soon as possible after submittals made to Contracting Officer or Contracting Officer's Representative are approved, submit copy of approved submittal to the Commissioning Authority.
- B. Product Data: If submittals to Contracting Officer or Contracting Officer's Representative do not include the following, submit copies as soon as possible:
 - 1. Manufacturer's product data, cut sheets, and shop drawings.
 - 2. Manufacturer's installation instructions.
 - 3. Startup, operating, and troubleshooting procedures.
 - 4. Fan and pump curves.
 - 5. Factory test reports.
 - 6. Warranty information, including details of Government's responsibilities in regard to keeping warranties in force.
- C. Manufacturers' Instructions: Submit copies of all manufacturer-provided instructions that are shipped with the equipment as soon as the equipment is delivered.
- D. Startup Plans and Reports.
- E. Completed Prefunctional Checklists.
- F. Template Building Envelope Inspection Checklists

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

- A. Provide all standard testing equipment required to perform startup and initial checkout and required Functional Testing; unless otherwise noted such testing equipment will NOT become the property of Government.
- B. Calibration Tolerances: Provide testing equipment of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:
 - 1. Temperature Sensors and Digital Thermometers: Certified calibration within past year to accuracy of 0.5 degree F and resolution of plus/minus 0.1 degree F.
 - 2. Pressure Sensors: Accuracy of plus/minus 2.0 percent of the value range being measured (not full range of meter), calibrated within the last year.
 - 3. Calibration: According to the manufacturer's recommended intervals and when dropped or damaged; affix calibration tags or keep certificates readily available for inspection.
- C. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as

part of the work at no extra cost to Government; such equipment, tools, and instruments are to become the property of Government.

- D. Dataloggers: Independent equipment and software for monitoring flows, currents, status, pressures, etc. of equipment.
 - 1. Dataloggers required to for Functional Tests will be provided by the Commissioning Authority and will not become the property of Government.

PART 3 EXECUTION

3.01 COMMISSIONING PLAN

- A. Commissioning Authority has prepared the Commissioning Plan.
 - 1. Attend meetings called by the Commissioning Authority for purposes of completing the commissioning plan.
 - 2. Require attendance and participation of relevant subcontractors, installers, suppliers, and manufacturer representatives.
- B. Contractor is responsible for compliance with the Commissioning Plan.
- C. Commissioning Plan: The commissioning schedule, procedures, and coordination requirements for all parties in the commissioning process.
- D. Basis of Design Documentation (BOD): Detailed documentation of the functional requirements of the project; descriptions of the systems, components, and methods chosen to meet the design intent; assumptions underlying the design intent.
 - 1. Basis of Design Documentation is to be prepared by Design-Builder.
- E. Commissioning Schedule:
 - 1. Submit anticipated dates of startup of each item of equipment and system to Commissioning Authority within 60 days after award of Contract.
 - 2. Re-submit anticipated startup dates monthly, but not less than 4 weeks prior to startup.
 - 3. Prefunctional Checklists and Functional Tests are to be performed in sequence from components, to subsystems, to systems.
 - 4. Provide sufficient notice to Commissioning Authority for delivery of relevant Checklists and Functional Test procedures, to avoid delay.

3.02 STARTUP PLANS AND REPORTS

- A. Startup Plans: For each item of equipment and system for which the manufacturer provides a startup plan, submit the plan not less than 8 weeks prior to startup.
- B. Startup Reports: For each item of equipment and system for which the manufacturer provides a startup checklist (or startup plan or field checkout sheet), document compliance by submitting the completed startup checklist prior to startup, signed and dated by responsible entity.
- C. Submit directly to the Commissioning Authority.

3.03 PREFUNCTIONAL CHECKLISTS

- A. A Prefunctional Checklist is required to be filled out for each item of equipment or other assembly specified to be commissioned.
 - 1. No sampling of identical or near-identical items is allowed.
 - 2. These checklists do not replace manufacturers' recommended startup checklists, regardless of apparent redundancy.
 - 3. Prefunctional Checklist forms will not be complete until after award of the contract; the following types of information will be gathered via the completed Checklist forms:
 - a. Certification by installing contractor that the unit is properly installed, started up, and operating and ready for Functional Testing.
 - b. Confirmation of receipt of each shop drawing and commissioning submittal specified, itemized by unit.
 - c. Manufacturer, model number, and relevant capacity information; list information "as specified," "as submitted," and "as installed."
 - d. Serial number of installed unit.

- e. List of inspections to be conducted to document proper installation prior to startup and Functional Testing; these will be primarily static inspections and procedures; for equipment and systems may include normal manufacturer's start-up checklist items and minor testing.
 - f. Sensor and actuator calibration information.
- 4. PECl (Samples) found at <http://www.peci.org/library/mcpgs.htm> indicate anticipated level of detail for Prefunctional Checklists.
- B. Contractor is responsible for filling out Prefunctional Checklists, after completion of installation and before startup; witnessing by the Commissioning Authority is not required unless otherwise specified.
 - 1. Each line item without deficiency is to be witnessed, initialed, and dated by the actual witness; checklists are not complete until all line items are initialed and dated complete without deficiencies.
 - 2. Checklists with incomplete items may be submitted for approval provided the Contractor attests that incomplete items do not preclude the performance of safe and reliable Functional Testing; re-submission of the Checklist is required upon completion of remaining items.
 - 3. Individual Checklists may contain line items that are the responsibility of more than one installer; Contractor shall assign responsibility to appropriate installers or subcontractors, with identification recorded on the form.
 - 4. If any Checklist line item is not relevant, record reasons on the form.
 - 5. Contractor may independently perform startup inspections and/or tests, at Contractor's option.
 - 6. Regardless of these reporting requirements, Contractor is responsible for correct startup and operation.
 - 7. Submit completed Checklists to Commissioning Authority within two days of completion.
- C. Commissioning Authority is responsible for furnishing the Prefunctional Checklists to Contractor.
 - 1. Initial Drafts: Contractor is responsible for initial draft of Prefunctional Checklist where so indicated in Contract Documents.
 - 2. Provide all additional information requested by Commissioning Authority to aid in preparation of checklists, such as shop drawing submittals, manufacturers' startup checklists, and O&M data.
 - 3. Commissioning Authority may add any relevant items deemed necessary regardless of whether they are explicitly mentioned in Contract Documents or not.
 - 4. When asked to review the proposed Checklists, do so in a timely manner.
- D. Commissioning Authority Witnessing: Required for:
 - 1. Each piece of primary equipment, unless sampling of multiple similar units is allowed by the commissioning plan.
 - 2. A sampling of non-primary equipment, as allowed by the commissioning plan.
- E. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Government.
 - 1. If difficulty in correction would delay progress, report deficiency to the Commissioning Authority immediately.

3.04 FUNCTIONAL TESTS

- A. A Functional Test is required for each item of equipment, system, or other assembly specified to be commissioned, unless sampling of multiple identical or near-identical units is allowed by the final test procedures.
- B. Contractor is responsible for execution of required Functional Tests, after completion of Prefunctional Checklist and before closeout.
- C. Commissioning Authority is responsible for witnessing and reporting results of Functional Tests, including preparation and completion of forms for that purpose.

- D. Contractor is responsible for correction of deficiencies and re-testing at no extra cost to Government; if a deficiency is not corrected and re-tested immediately, the Commissioning Authority will document the deficiency and the Contractor's stated intentions regarding correction.
1. Deficiencies are any condition in the installation or function of a component, piece of equipment or system that is not in compliance with Contract Documents or does not perform properly.
 2. When the deficiency has been corrected, the Contractor completes the form certifying that the item is ready to be re-tested and returns the form to the Commissioning Authority; the Commissioning Authority will reschedule the test and the Contractor shall re-test.
 3. Identical or Near-Identical Items: If 10 percent, or three, whichever is greater, of identical or near-identical items fail to perform due to material or manufacturing defect, all items will be considered defective; provide a proposal for correction within 2 weeks after notification of defect, including provision for testing sample installations prior to replacement of all items.
 4. Contractor shall bear the cost of Government and Commissioning Authority personnel time witnessing re-testing.
 5. Contractor shall bear the cost of Government and Commissioning Authority personnel time witnessing re-testing if the test failed due to failure to execute the relevant Prefunctional Checklist correctly; if the test failed for reasons that would not have been identified in the Prefunctional Checklist process, Contractor shall bear the cost of the second and subsequent re-tests.
- E. Functional Test Procedures:
1. Some test procedures are included in Contract Documents; where Functional Test procedures are not included in Contract Documents, test procedures will be determined by the Commissioning Authority with input by and coordination with Contractor.
 2. Examples of Functional Testing:
 - a. Test the dynamic function and operation of equipment and systems (rather than just components) using manual (direct observation) or monitoring methods under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint).
 - b. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc.
 - c. Systems are run through all the HVAC control system's sequences of operation and components are verified to be responding as the sequence's state.
 - d. Traditional air or water test and balancing (TAB) is not Functional Testing; spot checking of TAB by demonstration to the Commissioning Authority is Functional Testing.
 3. PECl (Samples) found at <http://www.peci.org/library/mcpgs.htm> indicated anticipated level of detail for Functional Tests.
- F. Deferred Functional Tests: Some tests may need to be performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions; performance of these tests remains the Contractor's responsibility regardless of timing.

3.05 SENSOR AND ACTUATOR CALIBRATION

- A. Calibrate all field-installed temperature, relative humidity, carbon monoxide, carbon dioxide, and pressure sensors and gauges, and all actuators (dampers and valves) on this piece of equipment shall be calibrated. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.
- B. Calibrate using the methods described below; alternate methods may be used, if approved by Commissioning Authority and Owner beforehand. See PART 2 for test instrument

requirements. Record methods used on the relevant Prefunctional Checklist or other suitable forms, documenting initial, intermediate and final results.

- C. All Sensors:
 - 1. Verify that sensor location is appropriate and away from potential causes of erratic operation.
 - 2. Verify that sensors with shielded cable are grounded only at one end.
 - 3. For sensor pairs that are used to determine a temperature or pressure difference, for temperature make sure they are reading within 0.2 degree F of each other, and for pressure, within tolerance equal to 2 percent of the reading, of each other.
 - 4. Tolerances for critical applications may be tighter.
- D. Sensors Without Transmitters - Standard Application:
 - 1. Make a reading with a calibrated test instrument within 6 inches of the site sensor.
 - 2. Verify that the sensor reading, via the permanent thermostat, gauge or building automation system, is within the tolerances in the table below of the instrument-measured value.
 - 3. If not, install offset, calibrate or replace sensor.
- E. Sensors With Transmitters - Standard Application.
 - 1. Disconnect sensor.
 - 2. Connect a signal generator in place of sensor.
 - 3. Connect ammeter in series between transmitter and building automation system control panel.
 - 4. Using manufacturer's resistance-temperature data, simulate minimum desired temperature.
 - 5. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter.
 - 6. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the building automation system.
 - 7. Record all values and recalibrate controller as necessary to comply with specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction.
 - 8. Reconnect sensor.
 - 9. Make a reading with a calibrated test instrument within 6 inches of the site sensor.
 - 10. Verify that the sensor reading, via the permanent thermostat, gauge or building automation system, is within the tolerances in the table below of the instrument-measured value.
 - 11. If not, replace sensor and repeat.
 - 12. For pressure sensors, perform a similar process with a suitable signal generator.
- F. Sensor Tolerances for Standard Applications: Plus/minus the following maximums:
 - 1. Watthour, Voltage, Amperage: 1 percent of design.
 - 2. Pressure, Air, Water, Gas: 3 percent of design.
 - 3. Air Temperatures (Outside Air, Space Air, Duct Air): 0.4 degrees F.
 - 4. Relative Humidity: 4 percent of design.
 - 5. Barometric Pressure: 0.1 inch of Hg.
 - 6. Flow Rate, Air: 10 percent of design.
 - 7. Flow Rate, Water: 4 percent of design.
 - 8. AHU Wet Bulb and Dew Point: 2.0 degrees F.
- G. Critical Applications: For some applications more rigorous calibration techniques may be required for selected sensors. Describe any such methods used on an attached sheet.
- H. Valve/Damper Stroke Setup and Check:
 - 1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
 - 2. Set pump/fan to normal operating mode.
 - 3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.

4. Command valve/damper to open; verify position is full open and adjust output signal as required.
 5. Command valve/damper to a few intermediate positions.
 6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).
- I. Isolation Valve or System Valve Leak Check: For valves not associated with coils.
1. With full pressure in the system, command valve closed.
 2. Use an ultra-sonic flow meter to detect flow or leakage.

3.06 TEST PROCEDURES - GENERAL

- A. Provide skilled technicians to execute starting of equipment and to execute the Functional Tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
- B. Provide all necessary materials and system modifications required to produce the flows, pressures, temperatures, and conditions necessary to execute the test according to the specified conditions. At completion of the test, return all affected equipment and systems to their pre-test condition.
- C. Sampling: Where Functional Testing of fewer than the total number of multiple identical or near-identical items is explicitly permitted, perform sampling as follows:
1. Identical Units: Defined as units with same application and sequence of operation; only minor size or capacity difference.
 2. Sampling is not allowed for:
 - a. Major equipment.
 - b. Life-safety-critical equipment.
 - c. Prefunctional Checklist execution.
 3. XX = the percent of the group of identical equipment to be included in each sample; defined for specific type of equipment.
 4. YY = the percent of the sample that if failed will require another sample to be tested; defined for specific type of equipment.
 5. Randomly test at least XX percent of each group of identical equipment, but not less than three units. This constitutes the "first sample."
 6. If YY percent of the units in the first sample fail, test another XX percent of the remaining identical units.
 7. If YY percent of the units in the second sample fail, test all remaining identical units.
 8. If frequent failures occur, resulting in more troubleshooting than testing, the Commissioning Authority may stop the testing and require Contractor to perform and document a checkout of the remaining units prior to continuing testing.
- D. Manual Testing: Use hand-held instruments, immediate control system readouts, or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").
- E. Simulating Conditions: Artificially create the necessary condition for the purpose of testing the response of a system; for example apply hot air to a space sensor using a hair dryer to see the response in a VAV box.
- F. Simulating Signals: Disconnect the sensor and use a signal generator to send an amperage, resistance or pressure to the transducer and control system to simulate the sensor value.
- G. Over-Writing Values: Change the sensor value known to the control system in the control system to see the response of the system; for example, change the outside air temperature value from 50 degrees F to 75 degrees F to verify economizer operation.
- H. Indirect Indicators: Remote indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100 percent closed, are considered indirect indicators.

- I. Monitoring: Record parameters (flow, current, status, pressure, etc.) of equipment operation using dataloggers or the trending capabilities of the relevant control systems; where monitoring of specific points is called for in Functional Test Procedures:
 1. All points that are monitored by the relevant control system shall be trended by Contractor; at the Commissioning Authority's request, Contractor shall trend up to 20 percent more points than specified at no extra charge.
 2. Other points will be monitored by the Commissioning Authority using dataloggers.
 3. At the option of the Commissioning Authority, some control system monitoring may be replaced with datalogger monitoring.
 4. Provide hard copies of monitored data in columnar format with time down left column and at least 5 columns of point values on same page.
 5. Graphical output is desirable and is required for all output if the system can produce it.
 6. Monitoring may be used to augment manual testing.

3.07 BUILDING ENVELOPE COMMISSIONING

- A. General: Comply with the following procedural requirements:
 1. ASTM E1827 Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door.
- B. The Commissioning Firm may act as the Pressure Test Agency for Air Barrier testing, provided that all qualification requirements are met.
- C. Verify that the building envelope has been sufficiently completed for testing to commence.
- D. Conduct ongoing inspections as construction progresses to document satisfactory installation conditions. related to thermal and moisture integrity of the building envelope that become concealed upon completion of construction. Complete and submit Building Envelope Inspection Checklists.
- E. Submit a detailed narrative of proposed pressure test procedures prior to the test. Include a plan view showing proposed installation locations (personnel doors or other similar openings) for blower doors (or flexible ducts for trailer-mounted fans, if used).
- F. Avoid testing on days forecast to experience high winds, rain, or snow.
- G. Test the completed building and demonstrate that the air leakage rate of the building envelope does not exceed the specified requirements.
 1. Use equipment and methods necessary to produce indoor/outdoor pressure differential of 0.2 inches w.g..
- H. Determine location and nature of undesirable air leakage pathways using methods specified in ASTM E1186-17 Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems.
- I. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Government.
 1. If difficulty in correction would delay progress, report deficiency to the Commissioning Authority immediately.

3.08 OPERATION AND MAINTENANCE MANUALS

- A. See Section 01 78 00 - Closeout Submittals for additional requirements.
- B. Add design intent documentation furnished by Contracting Officer or Contracting Officer's Representative to manuals prior to submission to Government.
- C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.
- D. Commissioning Authority will add commissioning records to manuals after submission to Government.

END OF SECTION

**SECTION 02 41 00
SELECTIVE DEMOLITION**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Selective demolition of built site elements.
- B. Selective demolition of building elements for alteration purposes.
- C. Abandonment and removal of existing utilities and utility structures.

1.02 DEFINITIONS

- A. Demolish: Dismantle, raze, destroy, or wreck any building or structure or any part thereof.
- B. Remove: Detach or dismantle items from existing construction and dispose of them off site, unless items are indicated to be salvaged or reinstalled.
- C. Remove and Salvage: Detach or dismantle items from existing construction in a manner to prevent damage. Clean, package, label and deliver salvaged items to Government in ready-for-reuse condition.
- D. Remove and Reinstall: Detach or dismantle items from existing construction in a manner to prevent damage. Clean and prepare for reuse and reinstall where indicated.
- E. Existing to Remain: Designation for existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

1.03 REFERENCE STANDARDS

- A. 29 CFR 1926 - Safety and Health Regulations for Construction.
- B. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Site Plan: Indicate:
 - 1. Areas for temporary construction and field offices.
 - 2. Areas for temporary and permanent placement of removed materials.
- C. Demolition Plan: Submit demolition plan as required by OSHA and local AHJs.
 - 1. Indicate extent of demolition, removal sequencing, bracing and shoring, and location and construction of barricades and fences.
 - 2. Summary of safety procedures.
 - 3. Demolition firm qualifications.
- D. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Fill Material: See Section 31 23 23.

PART 3 EXECUTION**3.01 DEMOLITION**

- A. Remove paving and curbs required to accomplish new work.
- B. Remove all other paving and curbs within site boundaries.
- C. Within area of new construction, remove foundation walls and footings to minimum 2 feet below finished grade.
- D. Remove concrete slabs on grade within site boundaries.
- E. Remove manholes and manhole covers, curb inlets and catch basins.

- F. Remove other items indicated, for salvage, relocation, and recycling.
- G. Fill excavations, open pits, and holes in ground areas generated as result of removals, using specified fill; compact fill as specified in Section 31 22 00.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with requirements in Section 01 70 00.
- B. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Comply with applicable requirements of NFPA 241.
 - 3. Use of explosives is not permitted.
 - 4. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 5. Provide, erect, and maintain temporary barriers and security devices.
 - 6. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
 - 7. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 - 8. Do not close or obstruct roadways or sidewalks without permits from authority having jurisdiction.
 - 9. Conduct operations to minimize obstruction of public and private entrances and exits. Do not obstruct required exits at any time. Protect persons using entrances and exits from removal operations.
 - 10. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon, or limit access to their property.
- C. Do not begin removal until receipt of notification to proceed from Government.
- D. Protect existing structures and other elements to remain in place and not removed.
 - 1. Provide bracing and shoring.
 - 2. Prevent movement or settlement of adjacent structures.
 - 3. Stop work immediately if adjacent structures appear to be in danger.
- E. Minimize production of dust due to demolition operations. Do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
- F. Hazardous Materials:
 - 1. If hazardous materials are discovered during removal operations, stop work and notify Contracting Officer or Contracting Officer's Representative and Government; hazardous materials include regulated asbestos containing materials, lead, PCBs, and mercury.
 - 2. Hazardous Materials: Comply with 29 CFR 1926 and state and local regulations.
- G. Perform demolition in a manner that maximizes salvage and recycling of materials.
 - 1. Comply with requirements of Section 01 74 19 - Construction Waste Management and Disposal.
 - 2. Dismantle existing construction and separate materials.
 - 3. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.
- H. Partial Removal of Paving and Curbs: Neatly saw cut at right angle to surface.

3.03 EXISTING UTILITIES

- A. Coordinate work with utility companies. Notify utilities before starting work, comply with their requirements, and obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.

- D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Government.
- E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Government.
- F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

3.04 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Existing construction and utilities indicated on drawings are based on casual field observation and existing record documents only.
 - 1. Verify construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Contracting Officer or Contracting Officer's Representative before disturbing existing installation.
 - 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Remove existing work as indicated and required to accomplish new work.
 - 1. Remove items indicated on drawings.
- C. Services including, but not limited to, HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications: Remove existing systems and equipment as indicated.
 - 1. Maintain existing active systems to remain in operation, and maintain access to equipment and operational components.
 - 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - 3. Verify that abandoned services serve only abandoned facilities before removal.
 - 4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings. Remove back to source of supply where possible, otherwise cap stub and tag with identification.
- D. Protect existing work to remain.
 - 1. Prevent movement of structure. Provide shoring and bracing as required.
 - 2. Perform cutting to accomplish removal work neatly and as specified for cutting new work.
 - 3. Repair adjacent construction and finishes damaged during removal work.
 - 4. Patch to match new work.

3.05 DEBRIS AND WASTE REMOVAL

- A. Remove debris, junk, and trash from site.
- B. Remove materials not to be reused on site; comply with requirements of Section 01 74 19 - Waste Management.
- C. Leave site in clean condition, ready for subsequent work.
- D. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

**SECTION 03 10 00
CONCRETE FORMWORK**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. This Section covers the concrete formwork for construction of all concrete structures set forth on the Drawings and in these Specifications.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
1. ACA: An acronym for Ammoniacal Copper Arsenate, a leach-resistant waterborne wood preservative.
 2. CCA: An acronym for Chromated Copper Arsenate, a leach-resistant waterborne wood preservative.
 3. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. American Concrete Institute (ACI):
1. ACI 117: Specification for Tolerances for Concrete Construction and Materials and Commentary
 2. ACI 347: Guide to Formwork for Concrete.
 3. ACI 350: Code Requirements for Environmental Engineering Concrete Structures and Commentary.
- C. U.S. Department of Commerce Product Standards:
1. PS 1: Construction and Industrial Plywood.
 2. PS 20: American Softwood Lumber Standard.
- D. Western Wood Products Association (WWPA):
1. WWPA Product Use Manual.
- E. American Plywood Association (APA):
1. APA Grade - Trademarks.
- F. Southern Pine Inspection Bureau (SPIB):
1. Standard Grading Rules for Southern Pine Lumber.

1.03 SUBMITTALS

- A. Form Coating: Submit manufacturer's descriptive product data and current specification covering named product, include certification that material is acceptable for use in structures processing or storing potable water.
- B. Form Ties: Submit manufacturer's descriptive product data, current specification covering named product and two samples.

1.04 QUALITY ASSURANCE

- A. Formwork Design: Provide formwork designed to ensure the tolerances indicated and to include factors pertinent to safety of personnel during construction.

1. Design formwork in accordance with ACI's Guide to Formwork for Concrete, ACI 347, and in accordance with the following:
 - a. Design forms and falsework to include assumed values of live load, dead load, weight of moving equipment operated on formwork, temporary construction material, foundation pressures, stresses, lateral stability, and such other factors pertinent to safety of structure during construction.
 - b. Design formwork to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent construction.
- B. Allowable Tolerances: Set and maintain concrete forms within tolerance limits stated in American Concrete Institute's Guide to Formwork for Concrete, ACI 347 and Specifications for Tolerances for Concrete Construction and Materials, ACI 117.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Protection:
 1. Protect formwork materials before, during, and after erection to ensure acceptable finished concrete work. Also protect in-place materials and work of other trades in connection with concrete work.
 2. In event of damage to erected forms, make necessary repairs or replacements prior to concrete pours. Perform such corrective work at no increase in Contract Price.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Lumber:
 1. Form framing, sheathing, struts, braces, and shoring in conformance with WWPA Product Use Manual or SPIB Grading Rules.
 2. Rough Structural and Dimension Lumber: Provide lumber of allowable species, surfaced four sides as applicable, and grade stamped with the appropriate WWPA or SPIB stamp indicating product compliance with PS 20.
 3. Use lumber free of material defects that would deform the finished concrete product.
- B. Plywood:
 1. Form Sheathing and Panels: Not less than 5/8 inch thick Exterior Type B-B Plywood Class I and II EXT-APA conforming to U.S. Product Standard PS 1.
 2. Use Class II only on surfaces not exposed to view.
- C. Steel:
 1. Metal Forms of a pre-engineered standard design, conforming to the concrete sections indicated on the Drawings, may be used in lieu of wood forms.
- D. Form Ties:
 1. Provide factory-fabricated, adjustable-length, removable or snap-off metal form ties conforming to ACI 347 and ACI 350.
 2. Use snap-off metal ties with ends that break at least 1½ inches from the face of the wall.
 3. Do not use removable ties that leave holes larger than one (1) inch.
 4. In construction of liquid-retaining structures and structures designed to exclude groundwater, use ties that are designed to prevent seepage or flow of water along the embedded item.
 5. Do not use removable type form ties in construction of liquid-retaining concrete structures.
 6. Do not use wire ties, flat bands, or form ties fabricated on the project site.
 7. Do not use wood spacers.

- E. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds. On surfaces which will be in contact with potable water, use no material which will add taste, odor, or toxic effects to the water.

PART 3 EXECUTION

3.01 INSPECTION

- A. Prior to placement of concrete, inspect forms for cleanliness and accuracy of alignment.

3.02 PREPARATION

- A. Apply form coatings in accordance with manufacturer's specifications.
- B. Do not allow excess form coating material to accumulate in the forms.
- C. Do not allow form coatings to come in contact with construction joints and reinforcing steel.

3.03 ERECTION

- A. General: Construct forms in accordance with ACI 347 to required dimensions, plumb, straight, mortar tight, and paste tight where appearance is important.
 - 1. Securely brace and shore forms to prevent displacement, bowing, and pillowing, and to safely support imposed concrete load.
 - 2. Provide offsets, keyways, recesses, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and such other features as required. Use selected materials to obtain above requirements.
 - 3. Fabricate forms for easy removal without hammering or prying against concrete surfaces.
 - 4. Form intersecting planes to provide true, clean-cut corners with edge grain of plywood not exposed to concrete.
 - 5. Build into forms, or otherwise secure in forms, items such as inserts, anchors, miscellaneous metal items, and such other embedded items as indicated on Drawings.
 - 6. Wet forms sufficiently to prevent joints in wood forms from opening prior to concrete pour.
 - 7. Do not use stay-in-place metal forms.
- B. Openings: Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete.
 - 1. Securely brace temporary openings and set tightly to forms to prevent the loss of concrete mortar. Locate temporary openings on forms in as inconspicuous a location as possible consistent with the requirements of the work.
 - 2. Provide openings in concrete formwork of the correct size and in the proper location to accommodate other items and operations of construction work passing through forms. Accurately place and securely support items to be built into forms.
- C. Earth Forms: Earth forms are not permitted.

3.04 CONSTRUCTION

- A. Form Removal
 - 1. Remove forms in accordance with ACI 347 without damage to concrete and in a manner to ensure complete safety and serviceability of the structure.
 - a. Do not cut form ties back from the face of the concrete.

- b. Concrete surface shall not contain residual form coating that will interfere with other materials or coatings to be applied.
2. Do not remove supporting forms or shoring until the members have acquired sufficient strength to safely support their weight and the anticipated construction loads without distortion or excessive deflection. The Contracting Officer's consent to remove forms does not relieve the Contractor of the responsibility for the safety of the work.
3. When the atmospheric temperature at the site has been continuously above 50 degrees F. from the time of the pour, the forms shall be removed at the earliest practical time within the limits set forth in this paragraph, and wet curing shall continue without delay.
 - a. Forms for walls and other vertical faces may be carefully removed 24 hours after the last portion of concrete in the section involved has been placed, provided the concrete has sufficiently hardened to preclude damage resulting from form removal, and provided these members are not subjected to loads for a period of 14 days.
 - b. Maintain horizontal forms in place for a minimum of 14 days or until the concrete, as determined by job-cured cylinders, has attained a compressive strength of 3,000 psi.
 - c. When a water-reducing retarder is used in the concrete mix, the normal time periods for removing forms may need to be increased.
4. When the atmospheric temperature at the site drops below 50° F, leave all forms in place for at least five (5) days regardless of the temperature within the protective covering or enclosure.
5. Upon removal of forms, notify the Contracting Officer in order that a review of the newly stripped surfaces may be made before patching.

3.05 RE-USE OF FORMS

- A. Forms for re-use shall meet new form requirements with respect to effect on poured concrete appearance and structural stability.
- B. Do not delay or change the concrete pour schedule as a result of reusing forms compared to the schedule obtainable if all forms were new (in the case of wood forms) or if the total required forms were available (in the case of metal forms).

3.06 SITE QUALITY CONTROL

- A. Inspections:
 1. Notify the Contracting Officer at least 10 days prior to scheduled concrete placement operations to allow sufficient time for the Testing and Inspection Agency (Approved Agency) responsible for performing the code-required special inspections to schedule an inspection of the concrete formwork.
 2. Prior to placement of concrete, inspect the forms for shape, location, and dimension of the concrete member being formed.
 - a. Provide lumber free of material defects that would unacceptably deform the finished concrete product or cause visible imperfections on surfaces exposed to public view.
 3. Prior to placement of concrete, verify the items to be embedded are properly placed and anchored.
- B. Non-Conforming Work:
 1. If formwork is found to be out of alignment or requires residual or other detrimental material to be removed from the forms or pour area, realign the forms and/or remove the detrimental material from the formwork before pouring concrete into the form.

3.07 WASTE MANAGEMENT AND DISPOSAL

- A. Do not leave any wood, shavings, sawdust, or similar items on the ground or buried in backfill.
 1. Do not burn scrap on the Work Site.
 - a. Do not burn scraps that have been pressure treated.

2. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or “waste-to-energy” facilities.

END OF SECTION

SECTION 03 11 19
INSULATING CONCRETE FORMWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies the furnishing and installing of permanent insulating concrete formwork as indicated on the Drawings.
- B. Adequate bracing and falsework shall be provided by the Installing Contractor to comply with all applicable codes.

1.02 RELATED SECTIONS:

- A. Concrete Reinforcement: 03 20 00
- B. Cast-In Place Concrete: 03 30 00.

1.03 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. *EPS*- Acronym for "Expanded Polystyrene" when referencing the insulating foam component of the Insulating Concrete Form System.
 - 2. *ICF*- Acronym for "Insulating (or Insulated) Concrete Form"
- B. Definitions:
 - 1. *Form Alignment System*- a form alignment & scaffold system designed exclusively for use with Insulating Concrete Forms.
 - 2. *Trained Installer*- An installation contractor, who has received instructional training in the installation of the specified Insulating Concrete Form System and is capable of providing written verification of his designation as such by the specified manufacturer of the system being installed.
 - 3. *Technical Associate*- A technical representative, usually a staff member of a Distribution Firm, who has received instructional training in the installation of Insulating Concrete Form system and is in the capacity of supervising an installation crew on site.
 - 4. *Window or Door Opening Buck*- a pre-manufactured or site constructed frame assembly consisting of wood or plastic material (or combination thereof) used to frame a rough opening within the forming system that will retain concrete around the opening. The frame can also provide for subsequent anchorage of doors and windows within the wall assembly.
- C. Reference Standards
 - 1. American Society for Testing and Materials (ASTM):
 - a. ASTM C165; Standard Test Method for Measuring Compressive Properties of Thermal Insulations.
 - b. ASTM C177; Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
 - c. ASTM C 203; Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
 - d. ASTM C 272; Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions.
 - e. ASTM C 303; Standard Test Method for Density of Preformed Block-Type Thermal Insulation.

- f. ASTM C 518; Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - g. ASTM C578; Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 - h. ASTM D 1621; Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
 - i. ASTM D 1622; Standard Test Method for Apparent Density of Rigid Cellular Plastics.
 - j. ASTM D1622: Standard Test Method for Apparent Density of Rigid Cellular Plastics
 - k. ASTM D 2126; Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging.
 - l. ASTM D 2863; Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
 - m. ASTM E 84; Standard Test Method for Surface Burning Characteristics of Building Materials.
 - n. ASTM E 90; Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - o. ASTM E 96; Standard Test Methods for Water Vapor Transmission of Materials.
 - p. ASTM E336: Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings.
 - q. ASTM E2634: Standard Specification for Flat Wall Insulating Concrete Form (ICF) Systems
- 2. International Code Council (ICC-ES):
 - a. AC12: Acceptance Criteria for Foam Plastic Insulation
 - b. AC15: Concrete Floor, Roof and Wall Systems and Concrete Masonry Wall Systems
 - c. AC 353: Stay-in-place, Foam Plastic Insulating Concrete Form (ICF) Systems for Solid Concrete
 - 3. National Fire Protection Association (NFPA)
 - a. NFPA 259: Standard Test Method for Potential Heat of Building Materials
 - b. NFPA 268: Standard Test Method for Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source
 - c. NFPA 285: Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components
 - d. NFPA 286: Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth
 - 4. American Concrete Institute (ACI):
 - a. ACI 301; Standard Specification for Structural Concrete.
 - b. ACI 117; Specifications for Tolerances for Concrete Construction and Materials and Commentary.
 - c. ACI 318; Building Code Requirements for Structural Concrete with Commentary.
 - d. ACI 347; Guide to Formwork for Concrete.
 - 5. National Fire Protection Association (NFPA)
 - a. NFPA 259: Standard Test Method for Potential Heat of Building Materials
 - b. NFPA 268: Standard Test Method for Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source
 - c. NFPA 285: Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components
 - d. NFPA 286: Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth

1.04 SYSTEM DESCRIPTION

- A. Formwork Design: Provide formwork designed to ensure the tolerances indicated and to include factors pertinent to safety of personnel during construction.

1. Design formwork in accordance with American Concrete Institute's Guide to Formwork for Concrete, ACI 347, and in accordance with the following:
 - a. Design forms to include assumed values of live load, dead load, temporary construction material, foundation pressures, stresses, lateral stability, wet weight of concrete and such other factors pertinent to safety of structure during construction.
- B. Allowable Tolerances: Set and maintain concrete forms within tolerance limits stated in American Concrete Institute's Guide to Formwork for Concrete, ACI 347 and Specifications for Tolerances for Concrete Construction and Materials and Commentary ACI 117.
- C. Performance Requirements:
 1. Insulated concrete wall forming system shall consist of 2 flame resistant panels of expanded polystyrene (EPS) connected by either high-density polypropylene webs, recycled PVC studs and I beams, or EPS embedded fastening strips interconnected with slide in format – high density polypropylene web connectors.
 2. All web fastening strips are to run full height of form and be fitted top and bottom with interlocking mechanisms to enable positive vertical interlocking of forms. Web systems to provide a minimum 38mm [1 ½"] wide fastening strip @ 152mm [6"] on center approximately 13mm [1/2"] below wall face for full wall height to facilitate finish fastening of both interior and exterior finishes.
 3. Full height fastening strips are also to be positioned within the corner forms to provide capability of connecting finishes full height within 100mm [4"] or less of corner conditions.
 4. Wall system to provide accurate positioning of steel within form cavity that conforms to the reinforcing requirements set forth in ACI 318 and the contract drawings.

1.05 SUBMITTALS

- A. Manufacturer's product data, specifications and installation instructions for each product specified.
- B. Detailed drawings showing layout, locations of form types, applicable structural details and other accessories.
- C. Dimensioned construction joint layout.
- D. The contractor shall submit written verification of credentials of the subcontractor responsible for the form system installation (*trained installer*) designated to be installing the ICF product as follows:
 1. That the installing contractor is either:
 2. An experienced ICF Contractor (*trained installer*) with a minimum of 5 years' experience in commercial ICF construction or;
 3. A qualified masonry or traditional concrete forming contractor with a minimum of 8 years' experience in commercial construction applications.
 4. That the installing contractor has demonstrated experience on supervising commercial construction projects of with gross floor areas of 50,000 ft² or greater. (Submit project name(s)/ location(s)).
- E. Test and Evaluation Reports:
 1. *Technical Associate* for form system shall submit on request, relevant laboratory tests or data that validate product compliance with performance criteria specified prior to commencement of work under this Section.
 2. Submit copy of valid product evaluation report, demonstrating compliance with this specification and applicable codes for site condition.
- F. Samples: Provide selection and verification samples.

1. Provide a sample wall mock-up panel to include full wall system and details. Contracting Officer to determine location (may be part of the construction if elected by the Contracting Officer).
- G. Form Alignment System Engineering:
 1. For wall heights above 12 feet (3.6m) of unsupported wall height, the contractor shall provide scaffold engineering for support of the Form Alignment System for support of the form system and the Form Alignment System assemblies during construction. Scaffolding system to be designed and sealed by a Professional Engineer in the Commonwealth of Pennsylvania competent in the design of scaffolding for the support of Form Alignment Systems.
- H. Additional shoring and/or wall support during construction. The contractor is responsible for all required shoring and/or wall support during construction and until the building has been braced against lateral forces (to include but not limited to complete floor and roof system installation).
- I. Quality Assurance/Control Submittals: Submit the following:
 1. Test Reports: Provide test data in support of performance requirements specified. See 033000 for concrete testing requirements. .
 2. Certificates: Submit certifications specified in this section.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Installer having demonstrated experience with work of scope and scale comparable to the project with a record of successful in-service performance.
 1. Contractor shall engage the services of a Trained Installer or Technical Associate for the duration of the work under this Section who has been trained in procedures pertaining to the correct installation of the specified form system (Trained installer may already be the designated ICF Installing Contractor if providing credentials as such).
 2. Contractor/Installer shall submit proof of training documentation to Contracting Officer prior to commencement of work under the Section.
- B. Regulatory Requirements and Approvals: Comply with the requirements of the following code criteria:
 1. International Building Code: ICC ES
- C. Engineering Calculations: Provide structural calculations sealed by a Professional Engineer.
- D. Certifications: Manufacturer's signed certification that product complies with the requirements of this section.
- E. Mock-ups:
 1. Construct sample wall mock-up panel to include full wall system and details, located where directed by Contracting Officer. Panel may form part of finished work if approved by the Contracting Officer.
- F. Testing and Inspection Agency Qualifications
 1. An independent agency, acceptable to the Authority Having Jurisdiction qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
- G. Preinstallation Meetings:
 1. Meet at job site prior to installation of permanent insulating concrete formwork to review the requirements of this section.
 - a. Attendees:

- 1) Manufacturer's Representative(s).
 - 2) Installer.
 - 3) Special Inspector (or Approved Agency)
 - 4) Other entities directly affecting or affected by construction activities of this section.
 - 5) Contracting Officer.
2. Review potential interface conflicts, coordinate layout, review protection of product and coordinate spatial requirements for form alignment steel storage/ forming, anchorage and anchor rod device installation locations and tolerances.

1.07 DELIVERY, STORAGE & HANDLING

- A. Delivery and Acceptance Requirements:
 1. Trained Installer/Technical Associate to meet with Contractor prior to material delivery on site to co-ordinate provision of access, storage area, and protection of insulating concrete form product and spatial requirements for Form Alignment System placement steel storage & forming.
 2. unopened, undamaged containers with identification labels intact. Labels to include manufacturer, manufactured location, and batch/lot number.
 3. Trained Installer shall furnish product packaging labels to contractor as required to maintain traceability of product for duration of contract.
 4. Bulk of form shipment shall be delivered as pre-assembled units and folded flat to maximize shipping space. Only form panels and insert webs as may be required for floor interfaces or specialized construction on site are to be shipped unassembled but in labeled packages for traceability.
- B. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.
 1. Handle and store products in location to prevent damaging and soiling.
 2. Maintain form materials and accessories in original packaging (or provide similar protection to unpackaged form materials -should on-site storage prior to installation extend beyond 3 months).
 3. Form units and related form installation materials and equipment to be stored flat until time of use.
 4. Do not store bagged blocks or accessories in direct contact with the ground.
 5. Ensure that UV protection is provided for material if storage is for longer than 30 days.

1.08 PROJECT/SITE CONDITIONS

- A. Use appropriate measures for protection and curing of concrete.

1.09 WARRANTY

- A. Project Warranty: Provide Warranty to the Contracting Officer per the contract requirements.

PART 2 PRODUCTS

2.01 PERMANENT INSULATING CONCRETE FORMING SYSTEM

- A. Acceptable Manufacturers
 1. NUDURA Corporation, www.nudura.com
 2. AMVIC Building System, www.alleguard.com
 3. LOGIX Insulated Concrete Block, www.logixicf.com.
 4. Or Approved Equal.

- B. One manufacturer will supply all wall and components for project.

2.02 DESCRIPTION

A. General:

1. Insulating concrete form system shall consist of two (2) flame resistant panels of expanded polystyrene (EPS) connected by either high-density polypropylene hinged pin foldable webs or EPS embedded polystyrene fastening strips interconnected with slide in format - high density polypropylene web connectors. EPS foam panels shall feature continuous vertical dove tail grooves on interior panel surfaces to provide integral surface bonding to concrete core once filled and concrete is cured. Dove tail grooves shall also facilitate structural linkage with end cap forms placed into the form cavity where required as part of the overall architectural design layout.
2. All web fastening strips to run full height of form and be fitted top and bottom with reversible fitting, "triple-tooth" interlocking mechanisms to enable positive vertical interlocking of forms with each other. Wall system webs to provide minimum 1 1/2" (38mm) wide fastening strips at 8-inches (203mm) on center approx 5/8-inch (15.9 mm) below insulation face to facilitate finish fastening of both interior and exterior finishes.
3. Insulating concrete form system shall be capable of forming ALL required wall systems as noted on the contract drawings.
4. Insulating concrete form system shall provide a minimum insulation panel thickness of 2 5/8-inches throughout ALL forms and panels forming the form system product inventory (with exception of variance required for brick ledge and tapered top forms).
5. All form units of wall forming system shall be capable of being shipped to site in folded condition to minimize shipping cost and site storage space requirement and be capable of being deployed to installation ready condition by simply unfolding the unit in a single pull motion or pull motion combined with insertion of a single web (at corner condition).
6. Standards, corner forms and stand alone panels of form system shall provide fully reversible interlocks along top and bottom edges to assure minimum product waste on site. EPS foam panels shall be molded with 1-inch wide by 1/2-inch high/deep alternating male/female reversible projection/socket interlocks positioned in pairs along both top and bottom edges of all panels.
7. Wall system shall be capable of providing horizontal and vertical lock positioning of steel within form cavity to conform to all reinforcing requirements of ACI 318.

B. Regulatory Requirements:

1. Form system manufacturer shall provide on request, written documentation verifying active compliance to ICC-ES Acceptance Criteria AC-308 "Stay-in-place, Foam Plastic Insulating Concrete Form (ICF) Systems for Solid Concrete", with valid listing in the report verifying qualification of form system for use in Types I through V construction as qualified under the governing Building Code for this project

C. Documentation as provided shall verify compliance to the following regulatory documents and standards:

1. Form system structural, and general performance assessment of properties of EPS foam and polypropylene materials assessment in accordance with the following standards:
 - a. ASTM C578: Standard Specification for Rigid, Cellular Polystyrene Thermal
2. Insulation (which includes results for);
 - a. ASTM C165: Standard Test Method for Measuring Compressive Properties of Thermal Insulation
 - b. ASTM C177: Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
 - c. ASTM C203: Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation
 - d. ASTM C272: Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions

- e. ASTM C303: Standard Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation
- f. ASTM C518: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
- g. ASTM D1621: Standard Test Method for Compressive Properties Of Rigid Cellular Plastics
- h. ASTM D1622: Standard Test Method for Apparent Density of Rigid Cellular Plastics
- i. ASTM D2126: Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
- j. ASTM D2863: Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
- k. ASTM E96: Standard Test Methods for Water Vapor Transmission of Materials
- 3. Finish attachment testing in accordance with:
 - a. ASTM D1761: Standard Test Methods for Mechanical Fasteners in Wood (Modified for Polypropylene Web assessment)
- 4. Surface Burning, Flash Ignition and Self Ignition Temperature Characteristics assessment of both plastic web and EPS form materials in accordance with:
 - a. ASTM D635: Standard Test Method for Rate of Burning and/or Extent and of Burning of Plastics in a Horizontal Position
- 5. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials
 - a. ASTM D1929: Standard Test Method for Determining Ignition Temperature of Plastics
- 6. Verification of performance and compliance of finishes for provision thermal barrier protection to foam plastic.
 - a. NFPA 286: Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth or...
- 7. Fire Resistance Rated Construction assessment in accordance with:
 - a. UL 263: Fire Tests of Building Construction and Materials
- 8. Non-Combustible Construction assessment (i.e. approved non-combustible material finish requirement documentation) in accordance with:
 - a. NFPA 259: Standard Test Method for Potential Heat of Building Materials
 - b. NFPA 268: Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source.
- 9. Assessment of non-combustible finishes verifying exterior protection of foam plastic insulation in accordance with one of the following standards:
 - a. NFPA 285: Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components.
- 10. Additional Testing and engineering documentation to verify qualification of EPS foam panels as a Vapor Retarder in conjunction with testing to:
 - a. ASTM E-96 Standard Test Methods for Water Vapor Transmission of Materials
- 11. Testing and engineering documentation to verify qualification of fully assembled wall system as an air barrier element in accordance with:
 - a. ASTM E1677 Standard Specification for an Air Retarder (AR) Material or System for Low-Rise Framed Building Walls
- 12. Testing and engineering documentation to verify qualification of the form system as meets the minimum STC performance requirements of 50 in accordance with:
 - a. ASTM E 90: Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements, or;
 - b. ASTM E 336: Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings.
- 13. Sustainability Characteristics:
 - a. When required by Contracting Officer, Technical Associate for the form system shall provide, written documentation verifying product recycle content and manufacturing location compliances with respect to USGBC/LEED® document submissions.

2.03 PERFORMANCE / DESIGN CRITERIA

- A. Capacities:
1. Selected system in conjunction with concrete and designated exterior and interior finishes shall provide minimum insulation level of R 23.59 (hr.ft².F/Btu) or (RSI 4.158 (m².K/W) - U Factor 0.2405 W/m².K) across full line of form unit cavity widths.
 2. EPS foam panels forming part of wall system shall provide maximum vapor permeation rate of 0.78 Perm-inch.(36 ng/Pa.s.m²) based on 2 5/8-inches (66.7 mm) singles thickness of foam on interior surface of concrete core.
 3. Finished wall assembly formed by system shall provide minimum sound transmission class (STC) sound attenuation performance as follows:
 - a. 4-inch (100mm) core form (if specified):
 - 1) STC 42 (when installed with ½-inch (12.7 mm) gypsum board both sides)
 4. (Not to be used for demising walls unless specified otherwise by architect)
 5. STC 52 (when installed as specified by manufacturer with additional hat channel and acoustic material with 5/8-inch (15.9 mm) finish on one side (½-inch (12.7 mm) gypsum board opp.).
 6. 6-inch (152mm) core form
 7. STC 50 (with regular ½-inch (12.7 mm) gypsum board both sides)
 8. Finished insulating concrete form wall assembly shall be capable of providing fire resistance ratings as listed in this section. Manufacturers of the specified wall assembly number (BXUV.U930) shall be actively listed and classified with Underwriters Laboratories Inc. Listings shall be verifiable under Certifications Directory of UL at:
 - a. <http://database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/index.html>
- B. Fire resistance ratings shall be established by testing in full accordance with ASTM E84 (latest code adopted edition) when installed as per the listed classification.

2.04 MATERIALS

- A. Insulating Concrete Forming:
- B. Concrete:
1. Concrete supplied under Section 03 30 00 shall be of strength as specified (measured at 28 days). Recommended maximum aggregate size to be ½-inch aggregate for 4 & 6-inch cavity forms and, ¾-inch aggregate for 8-inch cavity forms and higher.
 2. Recommended concrete slump is 4 to 6-inches +/- 1-inch
 3. Recommended slump specification shall be attained through addition of super plasticizer/mid-range water reducing agents to achieve design mix strength and concrete flow-ability.
- C. Reinforcing Steel:
1. Reinforcing steel shall be as specified in Section 03 20 00 and shall be supplied under that Section for placement by the Form System's Trained Installer.
- D. Waterproofing:
1. Where specified, waterproofing shall be self-adhesive modified bituminous sheet waterproofing membrane as supplied by concrete form system manufacturer specific to the form system specified under this section. Material to be supplied under this Section & installed as specified under Section 07 13 52 (Modified Bituminous Sheet Waterproofing).
 2. Waterproofing material shall be EPS foam compatible.

2.05 ACCESSORIES

- A. Form Alignment System

1. The Trained Installer shall furnish and utilize the Wall Access and Form Alignment System (as supplied by the Manufacturer or approved equivalent) to facilitate construction of the wall assembly, and to provide adjustment for ensuring plumbness and straightness of the wall system during construction, just prior to concrete placement and immediately after concrete placement while form system is still adjustable to final finished position.
 2. Form Alignment System shall be OSHA compliant. Technical Associate shall supply engineering documentation pertaining to the "base" Form Alignment System components to verify compliance upon request.
- B. As specified under previous Section, for wall heights above 12-feet, the contractor shall provide scaffold engineering for Form Alignment System and/or supplementary shoring/support during construction.

PART 3 EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

- A. Comply with the instructions and recommendations of the Permanent Insulating Concrete Forming System manufacturer.

3.02 EXAMINATION

- A. Site Verification of Conditions: Verify layout matches drawings at all locations and that site conditions are appropriate for installation of forming and placement of Permanent Insulating Concrete Forming System.
- B. Do not proceed with work until unsatisfactory conditions have been corrected.

3.03 SURFACE PREPARATION

- A. Clean top of footing and slabs prior to starting installation of Permanent Insulating Concrete Forming System. Use methods and materials approved by Permanent Insulating Concrete Forming Manufacturer.

3.04 CONSTRUCTION

- A. ICF wall system wet weight of concrete at the bottom of the form shall be reviewed prior to construction by the ICF supplier and contractor.
- B. Special Techniques for Wall Installation:
1. Erect wall forms plumb, square and level.
 2. Plumb, square, diagonally brace against racking and securely attach to forms, wood bucks for doors, windows and other openings.
 3. Align joints and install forms in a running bond pattern.
 4. Properly reinforce all cuts and weak spots in forming blocks.
 5. Install sleeves for penetrations and anchors for interior walls into formwork before placing concrete.
 6. Service penetrations exceeding 16"X16" in area shall be reinforced.
 7. Install and securely tie reinforcing bars so that concrete, when placed, will fully surround all bars.
 8. Make lintels over door and window openings integral with wall by installing required reinforcing bars as shown on structural drawings.
 9. Place horizontal reinforcing bars in notches in panel connectors, staggering bars side to side.

10. Install vertical bars near center of wall forms.
 11. Place anchor bolts and straps at top of wall as shown on drawings.
 12. Cut chases for electrical cable and plumbing into the blocks using a router or hot knife after concrete has been placed and cured.
 13. Assure alignment of polypropylene furring strips to facilitate wall covering attachment.
- C. Interface with Other Work:
1. Where point loads from beams, girders or trusses are to be supported, increase wall width as shown on structural drawings.
 2. Make connections to joists and other walls using industry standard hardware and methods shown on drawings.
 3. Use 90-degree corner forms where shown on drawings.
 4. Provide formed openings where required for items to be embedded in or to pass through concrete work.
 5. Locate and set items to be cast directly into concrete.
 6. Coordinate with work of other trades in forming and placing openings, sleeves, anchor rods and other inserts.
 7. Install accessories in accordance with manufacturer's instructions, straight, level and plumb. Ensure items are not disturbed during concrete placement.
- D. General: Construct forms in accordance with ACI 347 to required dimensions, plumb, straight, mortar tight, and paste tight where appearance is important.
1. Securely brace and shore forms to prevent displacement, bowing and pillowing, and to safely support imposed concrete load.
 2. Provide offsets, keyways, recesses, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and such other features as required. Use selected materials to obtain above requirements.
 3. Build into forms, or otherwise secure in forms, items such as inserts, anchors, miscellaneous metal items, and such other embedded items as indicated on Drawings.
- E. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated within tolerance limits of ACI 117.
- F. Construct forms tight to prevent loss of concrete mortar.
- G. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.
- H. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
1. Close temporary ports and openings with tight fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.
- I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- K. Shore insulating concrete forms to ensure stability and to resist stress imposed by construction loads.
- L. Do not remove supporting forms or shoring until the members have acquired sufficient strength to safely support their weight and the anticipated construction loads without distortion or excessive deflection.

3.05 FIELD QUALITY CONTROL

- A. Provide Permanent Concrete Formwork to the tolerances set forth in this specification and Section 033000.
- B. Conform to Section 033000 for additional requirements of concrete construction.
- C. Prior to placement of concrete, inspect forms for shape, location, dimensions, cleanliness, reinforcing steel, embedments and accuracy of alignment.

3.06 CLEANING

- A. Clean forms as installation proceeds.
- B. Clean formed cavities of debris prior to placing concrete.
- C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean out ports.
- D. During cold weather, remove ice and snow from formwork. Do not use de-icing salts. Do not use water to clean out forms unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

3.07 PROTECTION

- A. Protect completed work from damage during subsequent construction activities on the site.

END OF SECTION

**SECTION 032000
CONCRETE REINFORCEMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. The work specified in this Section consists of furnishing and installing reinforcement for concrete structures.

1.02 RELATED WORK

- 1. Section 033000: Cast-in-Place Concrete.

1.03 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. ACI 315; Details and Detailing of Concrete Reinforcement.
 - 2. ACI 318; Building Code Requirements for Reinforced Concrete.
- B. ASTM International (ASTM):
 - 1. ASTM A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 2. ASTM A663: Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
 - 3. ASTM A706: Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - 4. ASTM A1064: Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
- C. Concrete Reinforcing Steel Institute (CRSI):
 - 1. Manual of Standard Practice.

1.04 SUBMITTALS

- A. Shop Drawings and Product Data:
 - 1. Prepare shop drawings of concrete reinforcement in accordance with ACI 315.
 - 2. Provide drawings showing all fabrication dimensions and locations for placing reinforcement and bar supports; indicate bending diagrams, splicing and lap of rods, shapes, dimensions and details of bar reinforcing, and accessories.
- B. Test Reports:
 - 1. Submit copies of reports showing the results of tests, conducted in accordance with ASTM Specifications.
 - 2. Test Requirements may be waived based upon certified copies of mill test reports.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Storage of Materials:
 - 1. Store reinforcing materials in a manner to prevent excessive rusting and fouling with dirt, grease, and other bond-breaking coatings.
 - a. Store the reinforcement and accessories aboveground on platforms, skids, or other supports.
 - b. Cover reinforcement and accessories.
 - 2. Identify bundles of reinforcing steel with tags wired to steel.
 - 3. Protect reinforcement from deforming, bending, kinking, and other injury.

1.06 PROJECT CONDITIONS

- A. Protection: Protect in-place reinforcement from excessive construction traffic and other work.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Reinforcing Steel:
 - 1. Reinforcement Bars: ASTM A615, Grade 60, deformed steel, which shall satisfy the exceptions in ACI Building Code, AASHTO, and Federal Specifications.
 - 2. Weldable Reinforcement Bars: ASTM A706; Grade 60 Deformed or Smooth.
 - 3. Wire: ASTM A1064.
 - 4. Welded Wire Fabric: ASTM A1064.
 - 5. Metal Accessories: CRSI Manual of Standard Practice.
- B. Rebar Splicing Coupler: A two-piece splicing system manufactured from ASTM A615 Grade 60 deformed rebar. A dowel bar splicer with integral nailing flange shall be threaded for a threaded down-in rebar such that the completed splice exceeds the tensile requirements of ACI 318.
 - 1. Internal Coupler Protector: Provide coupler manufacturer's plastic internal coupler protector where couplers are provided for anticipated future additions.
 - 2. Bar End Protectors: Plastic solid sleeve for placement over bar ends to protect threading from damage, contamination, and rust.
 - 3. Use Rebar Splicing Coupler only where shown on Drawings or where approved by the Contracting Officer.
 - 4. Acceptable Manufacturers:
 - a. Dayton Superior Corp.
 - b. Or approved equal.
- C. Doweled Expansion Joint
 - 1. Two piece system that consists of a closed end plastic sleeve and smooth dowel, size as indicated on drawings.
 - 2. Acceptable Manufacturers:
 - a. Greenstreak: Speed Dowel System.
 - b. Or approved equal.
- D. Doweled Contraction Joint
 - 1. Two-piece system that consists of a closed end plastic sleeve and smooth dowel, size as indicated on drawings.
 - 2. Acceptable Manufacturer:
 - a. Greenstreak: Speed Dowel System.
 - b. Or approved equal.
- E. Dowel Bars (for shear transfer)
 - 1. Plain round bar conforming to requirements of ASTM A663, Grade 70, 75, or 80 which is not burred, roughened, or deformed out-of-round so slippage is not hindered.

2.02 FABRICATION

- A. General: Fabricate reinforcement to the dimensions indicated on the Drawings and within the tolerances given in ACI 315. Perform bending of steel reinforcement by the cold bending method.
 - 1. Do not use bars with kinks or bends not indicated on Drawings.

2. Perform bar shape fabrication in a manner that will not injure the material or lessen the member strength.
3. Use a designed bending machine, either hand- or power-operated.
4. Do not field bend bars partially embedded in concrete unless approved by the Contracting Officer.

2.03 SOURCE QUALITY CONTROL

A. Tests and Inspections:

1. Materials specified in this Section require advance examination or laboratory testing according to the methods referenced herein.
2. The Testing and Inspection Agency (Approved Agency) will perform the source testing specified in this Paragraph, unless the testing is not required as specified.
 - a. The tests specified in Subparagraphs 2.03.A.3 through 2.08.A.7 may be waived if certified copies of mill test reports are submitted showing complete compliance with the specified requirements.
 - b. If the certified mill test reports are not submitted the Testing and Inspection Agency must perform the specified tests.
3. Deformed Steel Reinforcement Tests:
 - a. Test Procedure:
 - 1) The following properties of the deformed steel bar reinforcement will be determined using the methods specified in ASTM A615:
 - a) The carbon, manganese, phosphorus, and sulfur content of the dowel bar material.
 - b) The tensile strength, yield strength, and percentage elongation.
 - 2) The bend test will be performed on the deformed steel bar reinforcement using the methods specified in ASTM A615.
 - b. Acceptance Criteria:
 - 1) Deformed steel bar reinforcement that exhibit the chemical composition, tensile strength, yield strength, percent reduction of area, and weight (mass) per unit length within the ranges specified in ASTM A615, and that pass the bend test for the bar size, as specified in ASTM A615 are acceptable.
4. Steel Welded Wire Reinforcement Tests:
 - a. Test Procedure:
 - 1) The tensile strength, yield strength, and percent reduction of area will be determined, and the bend test for steel welded wire reinforcement will be performed in accordance with the methods specified in ASTM A1064.
 - b. Acceptance Criteria:
 - 1) Steel wire used to fabricate the steel welded wire reinforcement that exhibits the tensile strength, yield strength, and percent reduction of area within the ranges specified, and that passes the bend test for the wire size as specified in ASTM A1064 are acceptable.
5. Deformed Bar Anchor Tests:
 - a. Test Procedure:
 - 1) The tensile strength and yield strength will be determined, and the bend test for steel deformed bar anchors will be performed in accordance with the methods specified in ASTM A496.
 - b. Acceptance Criteria:
 - 1) Deformed bar anchors exhibiting the tensile strength and yield strength within the ranges specified in Subparagraph 2.01.E are acceptable.
6. Rebar Splicing Coupler:
 - a. Test Procedure:
 - 1) The following properties of the dowel bar used to fabricate the rebar splicer components will be determined using the methods specified in ASTM A615:
 - a) The carbon, manganese, phosphorus, and sulfur content of the dowel bar material.

- b) The tensile strength, yield strength, and percentage elongation.
 - 2) The bend test will be performed on the dowel bar used to fabricate the dowel bar splicer components using the methods specified in ASTM A615.
- b. Acceptance Criteria:
 - 1) Rebar splicer components that exhibit the chemical composition, tensile strength, yield strength, percent reduction of area, and weight (mass) per unit length within the ranges specified in ASTM A615, and pass the bend test for the bar size as specified in ASTM A615 are acceptable.
- 7. Non-Conforming Work:
 - a. Do not use concrete reinforcement that fails the testing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Placing:
 - 1. Place metal reinforcement accurately and securely brace against displacement within permitted tolerances and in accordance with ACI 318 through the use of reinforcing accessories.
 - 2. Terminate reinforcement two inches from face of expansion joints.
 - 3. Continue reinforcement across or through construction joints.
 - 4. When obstructions interfere with the placement of reinforcement, pass such obstructions by placing reinforcing around it. Do not bend the reinforcing to clear the obstructions.
 - 5. Install welded wire fabric as indicated, lapping joints eight inches and wiring securely. Extend welded wire fabric to within two inches of sides and ends of slabs.
 - 6. Do not lay metal reinforcement on formwork.
 - 7. Place slab reinforcement supported from the ground on concrete blocks of the correct height and having a compressive strength equal to or greater than the specified compressive strength of concrete being placed. Use concrete blocks not larger than 3 inches by 3 inches with a height equal to required bottom steel cover.
 - 8. Reinforcement supported from formwork for slabs and beams not exposed to weather or to a continuous wet environment may use bar chairs made of plastic or metal. Use stainless steel boosters in areas exposed to a wet environment.
 - 9. Place additional reinforcement around openings in slabs and walls as detailed on the Drawings.
- B. Concrete Reinforcement Field Bends:
 - 1. Do not field bend bars partially embedded in concrete.
 - 2. When obstructions interfere with the placement of reinforcement, pass such obstructions by placing reinforcement around it.
 - a. Do not bend the reinforcement to clear the obstructions.
- C. Shortening Concrete Reinforcement:
 - 1. Shorten (trim) concrete reinforcement, if required, by shearing or sawing.
 - 2. Shortening concrete reinforcement using an acetylene torch may be acceptable, but only if the location of the shortening is approved by the Contracting Officer in writing in advance.
- D. Splicing:
 - 1. Splice metal reinforcement as indicated on the Drawings and in accordance with ACI 318.
 - 2. Welding of crossing bars (tack welding) is not permitted.
 - 3. Secure metal reinforcement at intersections with not less than No. 16-gauge annealed wire or appropriate size clips. When bar spacing is less than 12 inches, tie alternate intersections.
 - 4. Make mechanical butt splices in accordance with rebar splicing coupler manufacturer's installation instructions.

- E. Dowel Bar Installation: Install one-half the length of coated bar dowel into slab to be poured.
- F. Cleaning: Clean or otherwise protect metal reinforcement so that at the time concrete is placed, reinforcement is free from rust, scale, or other coatings that will destroy or reduce bond.

3.02 SITE QUALITY CONTROL

- A. A Testing and Inspection Agency (Approved Agency) shall be engaged by Government to perform code-required special inspections.
 - 1. Written reports on all tests and inspections shall be provided immediately after work is performed. The reports shall state test specimens either comply with requirements or deviate from them.
- B. Inspections:
 - 1. Notify the Contracting Officer at least 10 days prior to scheduled concrete placement operations so the placement of reinforcement can be inspected.
 - 2. Prior to placing concrete, inspect the reinforcement size, location, spacing, clear distance between bars, and to the outside face of the concrete, and the reinforcement will not be displaced during the placement of concrete.
 - a. Verify the rebar splicer system is installed at the approved locations, is the correct type, and is installed in accordance with the manufacturer's guidelines.

3.03 PROTECTION

- A. Provide protection for concrete reinforcement during concrete pours in accordance with ACI 318, unless indicated otherwise on the Contract Drawings.
- B. Protect in-place reinforcement from excessive construction traffic and other work.

END OF SECTION

**SECTION 03 30 00
CAST-IN-PLACE CONCRETE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. The work specified in this Section consists of designing mix, furnishing, placing, and curing Portland Cement concrete, reinforced and unreinforced, as indicated.

1.02 RELATED WORK

- A. Section 03 10 00: Concrete Formwork.
- B. Section 03 11 19: Insulating Concrete Formwork
- C. Section 032000: Concrete Reinforcement.
- D. Work Provided Under Other Contracts: Items to be embedded in concrete are as specified in the various Sections of this Contract and other Contracts for this Project. The responsibility for coordinating concrete pours with embedded items rests solely with the Contractor.
- E. Work Specified Under Other Sections: Items to be embedded in concrete are as specified in the various Sections of this Contract Specification. The responsibility for coordinating concrete pours with embedded items rests solely with the Contractor.

1.03 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. H.E.S : High Early Strength.
 - 2. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
 - 1. Cementitious Material: Mixture of cement and one type of a cement replacement material.
 - 2. Flatness F-Number (F_F): A dimensionless number that defines the relative smoothness of a floor slab.
 - 3. Levelness F-Number (F_L): A dimensionless number that defines the relative conformity of a floor surface to a horizontal plane.
- C. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO M 182 Burlap cloth made from Jute or Kenaf and Cotton Mats.
- D. American Concrete Institute (ACI):
 - 1. ACI 117; Specification for Tolerances for Concrete Construction and Materials.
 - 2. ACI 211.1; Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete – Procedures for Mix Design.
 - 3. ACI 211.2; Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
 - 4. ACI 301; Specifications for Structural Concrete.

5. ACI 302.1R; Guide for Concrete Floor and Slab Construction.
6. ACI 302.2R; Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.
7. ACI 304R; Guide for Measuring; Mixing, Transporting, and Placing Concrete.
8. ACI 304.2R; Placing Concrete by Pumping Methods.
9. ACI 305R; Guide to Hot Weather Concreting.
10. ACI 306R; Guide to Cold Weather Concreting.
11. ACI 308; Standard Practice for Curing Concrete.
12. ACI 318; Building Code Requirements.

E. ASTM International (ASTM):

1. ASTM C31; Standard Practice for Making and Curing Concrete Test Specimens in the Field.
2. ASTM C33; Standard Specification for Concrete Aggregates.
3. ASTM C39; Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4. ASTM C78; Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
5. ASTM C94; Standard Specification for Ready-Mixed Concrete.
6. ASTM C143; Standard Test Method for Slump of Hydraulic-Cement Concrete.
7. ASTM C150; Standard Specification for Portland Cement.
8. ASTM C171; Standard Specification for Sheet Materials for Curing Concrete.
9. ASTM C172; Standard Practice for Sampling Freshly Mixed Concrete.
10. ASTM C173; Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
11. ASTM C192; Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
12. ASTM C231; Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
13. ASTM C260; Standard Specification for Air-Entraining Admixtures for Concrete.
14. ASTM C309; Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
15. ASTM C494; Standard Specification for Chemical Admixtures for Concrete.
16. ASTM C595; Standard Specification for Blended Hydraulic Cements
17. ASTM C881; Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
18. ASTM C882; Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete By Slant Shear.
19. ASTM C989; Standard Specification for Slag Cement for Use in Concrete and Mortars.
20. ASTM C1157; Standard Performance Specification for Hydraulic Blended Cement.
21. ASTM C1260 – Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).

22. ASTM C1567; Standard Test Method for determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
23. ASTM D638; Standard Test Method for Tensile Properties of Plastics.
24. ASTM D695; Standard Test Method for Compressive Properties of Rigid Plastics.
25. ASTM C1610 Standard Test Method for Static Segregation of Self-Consolidating Concrete Using Column Technique
26. ASTM D1751; Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
27. ASTM D1752; Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
28. ASTM E329; Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
29. ASTM C138/C138M; Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
30. ASTM C1077; Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.
31. ASTM C1315; Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

F. Commonwealth of Pennsylvania Department of Transportation (PENNDOT) Specifications *Publication 408*, as supplemented.

1. [PENNDOT Section 704 Cement Concrete.](#)
2. [PENNDOT Section 1001 Cement Concrete Structures.](#)

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Before concrete is to be placed, give a 10-day advance notice to those performing other construction work related to the concrete pours, such as to those performing work that must be supported by or embedded in concrete, to allow such items to be introduced or furnished before the concrete is placed.
2. Coordinate with the Independent Quality Assurance Testing and Inspection Agency to ensure notification is received sufficiently early to allow them ample time to schedule and perform the required testing and inspection.

B. Pre-Installation Meetings:

1. Prior to placement of concrete, convene an onsite meeting to establish and coordinate procedures that will enable the Contractor to provide the best possible product under anticipated field conditions.
2. Required attendees to this meeting include representatives of organizations and material suppliers involved with the design and construction of concrete elements.

C. Scheduling:

1. A minimum of 30 days prior to placing concrete, submit a schedule showing proposed construction methods, construction joint locations, and the sequence of pouring for approval.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's descriptive product data and current specifications for the concrete accessories specified herein (admixtures, joint fillers, curing materials, floor hardeners, waterstops, etc.). Include installation instructions.
- B. Samples: Submit samples of materials being used when requested by the Contracting Officer including names, sources, and descriptions.
- C. Aggregate Testing for AAR: Prior to production of concrete, submit for approval testing as required by Article 2.01.C.2, Aggregate Reactivity.
- D. Design Mix: Prior to production of concrete, submit for approval, on form attached at the end of this Section, all mix designs proposed for project. Include with the mix design a standard deviation analysis or trial mixture test data in accordance with ACI 301 Section 4. Use materials in such proposed design mix as specified herein. Make such adjustments in the proposed design mix as directed by the Contracting Officer. Make such adjustments at no increase in contract price.
 1. Water shall not be added to concrete mix at the project site unless it is withheld from the mix at the batch mixing plant. Indicate amounts of mix water to be withheld for later addition at project site. If water is added to mix at the Site, perform additional revolutions at the mixing speed to adequately incorporate the additional water into the mixture.
 2. For High-Early Strength Concrete, provide an air-entrained mixture that attains a 24-hour compressive strength of 2,500 psi and a three (3) day strength of 3,500 psi. Data shall be provided to demonstrate the ability of the mixture to meet the specification requirements.
- E. Test Reports:
 1. Submit concrete test reports specified in Part 3, Field Quality Control in this Specification.
- F. Certificates:
 1. Furnish the Contracting Officer and local authorities requiring same, certificates originated by the batch mixing plant certifying ready mixed concrete, as manufactured and delivered, to be in conformance with ASTM C94.
- G. Delivery Tickets: A delivery ticket shall accompany each load of concrete from the batch plant.
 1. Tickets must be signed by the Contractor's representative, noted as to time and place of pour, and kept in a record at the site. Make such records available for inspection upon request by the Contracting Officer.
 2. Information presented on the ticket to include the tabulation covered by ASTM C94, Section 14, as well as any additional information the local codes may require.
- H. Schedule: Submit schedule showing methods, construction joint locations, and sequence of pouring a minimum of 10 days prior to placing concrete.

- I. Testing Agency: Submit name and qualifications of Testing and Inspection Agency to Building Official for approval prior to proceeding with testing.

1.06 QUALITY ASSURANCE

- A. Testing Agency: An agency regularly performing work conforming to ASTM E329.
- B. Source Quality Control:
 1. Laboratory Tests: Materials stated herein require advance examination or testing according to methods referenced or as required by the Contracting Officer.
- C. Compression Test Cylinders: For laboratory trial batches, make in accordance with ACI 301. Test to consist of three compression test cylinders for each class of concrete with one broken at seven days and two broken at 28 days; ASTM C192 and ASTM C39.
- D. The use of the High-Early Strength Concrete mix (as defined by requirements in this Section) shall only be installed at locations given prior approval by the Contracting Officer.

1.07 PROJECT CONDITIONS

- A. ACI Compliance: Cast-in-place concrete work shall conform to ACI 301 except as modified by these Specifications or the Drawings.
- B. Concrete Encasement of Pipes: Encase pipes under structures and buildings indicated by the Drawings to be encased in concrete for the full length of the pipe run under the structure.
- C. Concrete Encasement of Conduits: Encase conduit runs as indicated and detailed on the Electrical Drawings.
- D. Equipment Bases: Construct reinforced concrete bases for equipment and piping under this contract at no increase in contract price.

1.08 SEQUENCING

- A. Where other construction work is relative to concrete pours, or must be supported by or embedded in concrete, those performing such related work must be given five days' notice to introduce or furnish embedded items before concrete is placed.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cement:
 1. Portland Cement: ASTM C150 of the following Type:
 - a. Type I.
 2. Only one brand and manufacturer of approved cement shall be used for exposed concrete.
 3. Cementitious material is a mixture of cement and ground granulated blast-furnace slag (GGBFS).
- B. Pozzolan:

1. Ground Granulated Blast -Furnace Slag (GGBFS): Conform to ASTM C989, Grade 120, NSF approved for contact with potable water.
 - a. Use GGBFS at the rate of 25% (min) to 40% (max) of the total cementitious material.
 2. Fly-Ash: Conform to ASTM C618 Type F.
 - a. Maximum rate of 15% to 25% by weight of total cementitious material.
 - b. Maximum Loss of Ignition: Not to exceed 4%.
 3. Provide only one type of cement replacement material for entire project. The material selected shall be obtained from one source.
- C. Normalweight Concrete Aggregates: Process aggregate meeting requirements of ASTM C33 and subject to the following limitations.
1. Coarse Aggregate Size: Maximum size of coarse aggregate shall not exceed the following requirements but in no case larger than 1½ inches.
 - a. Coarse aggregates be #57 as graded within the limits in ASTM C33 unless otherwise specified.
 - b. One-fifth narrowest dimension between sides of forms within which concrete is to be cast.
 - c. Three-fourths of the minimum clear spacing between reinforcing bars.
 - d. One-third the slab thickness for unreinforced slabs.
 - e. Reduced aggregate concrete containing aggregate with particle size not less than 1/8 inch or more than 1/2 inch in any dimension and a maximum of 5 percent of particles passing a No. 8 sieve (for use in metal pan stairs only).
 2. Aggregate Reactivity:
 - a. Each aggregate source shall be tested in accordance with ASTM C 1260. Aggregates tested in accordance with ASTM C 1260 shall be considered potentially reactive if expansion exceeds 0.10% at 16 days after casting the specimens.
 - b. Aggregate sources that are shown to be potentially reactive based on testing in accordance with ASTM C 1260 or aggregate sources that are known to be susceptible to alkali-silica reactivity (ASR) based on field performance or prior testing shall not be used without additional testing in accordance with procedures in ASTM C 1567.
 - c. If necessary, testing in accordance with ASTM C1567 shall be performed using the proposed project materials to assess if slag can be successfully used to mitigate deleterious expansions, and the slag replacement percentage necessary such that expansion is less than 0.10 percent at 16 days after casting the specimens. Regardless of the results of ASTM C 1567 testing, the minimum slag replacement percentages specified above shall be met.
- D. Water: ASTM C1602. Clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or reinforcement.
- E. Provide H.E.S. concrete materials conforming to [PENNDOT Section 704](#).
- F. Concrete Admixtures:
1. Prohibited Admixtures: Use only non-corrosive, non-chloride admixtures.

2. Provide admixtures produced and serviced by established, reputable manufacturers and use in compliance with manufacturer's recommendations.
 3. Air-Entraining Admixture:
 - a. Use a product conforming to requirements of ASTM C260.
 - b. Acceptable Manufacturers:
 - 1) EUCON AEA-92; The Euclid Chemical Company.
 - 2) Sika Air; Sika Corporation.
 - 3) MasterAir Series; Master Builders Solutions US LLC.
 - 4) Or approved equal.
 4. Water-Reducing Admixture:
 - a. Use a product conforming to requirements of ASTM C494, Type A. (Use this for all concrete except where an admixture listed below is used).
 - b. Acceptable Manufacturers:
 - 1) Eucon WR91; The Euclid Chemical Company.
 - 2) MasterPolyHeed Series; Master Builders Solutions US LLC.
 - 3) Or approved equal.
 5. Water-Reducing and Retarding Admixture:
 - a. Use a product conforming to requirements of ASTM C494, Type D.
 - b. Acceptable Manufacturers:
 - 1) Eucon Retarder-75; The Euclid Chemical Company.
 - 2) Plastiment; Sika Corporation.
 - 3) MasterPolyHeed Series; Master Builders Solutions US LLC.
 - 4) Or approved equal.
 6. High-Range Water-Reducing Admixture:
 - a. Use a product conforming to the requirements of ASTM C494, Types A and F.
 - b. Acceptable Manufacturers:
 - 1) Eucon 37; The Euclid Chemical Company.
 - 2) Sika ViscoCrete 2100; Sika Corporation.
 - 3) MasterGlenium Series; Master Builders Solutions US LLC.
 - 4) Or approved equal.
 7. Water-Reducing, and Acceleration Admixture: Use a product conforming to requirements of ASTM C494, Types C or E. Not permitted for use in concrete for water retaining structures.
 - a. Acceptable Manufacturers:
 - 1) Accelguard 80; The Euclid Chemical Company.
 - 2) MasterSet AC 534 or MasterSet FP 20; Master Builders Solutions US LLC.
 - 3) Plastocrete 161 FL, Sika Rapid-1, or Sikaset series; Sika Corporation.
 - 4) Or approved equal.
 8. Store admixtures in a manner to prevent contamination, evaporation, moisture penetration, or damage. Do not use products which have been stored longer than 6 months.
 9. Prior to the mix design review by the Contracting Officer, provide written conformance to the specified requirements of the admixture.
- G. Preformed Expansion Joint Fillers:
1. Nonextruding and Resilient Bituminous Types (for exterior use in pavements and sidewalks only): ASTM D1751.
 2. Sponge Rubber and Cork Type: ASTM D1752.
 3. Self Expanding Cork Type: ASTM D1752.

4. Acceptable Manufacturers:
 - a. W.R Meadows Inc.
 - b. The Euclid Chemical Company/Tamms Industries, Inc.
 - c. Or approved equal.
- H. Curing Materials: Use curing materials that will not stain or affect concrete finish or lessen the concrete strength and comply with the following requirements:
 1. Burlap: Materials conforming to AASHTO M 182.
 2. Sheet Materials: Material conforming to ASTM C171.
 3. Liquid Curing Compound.
 - a. Use material meeting the requirements of ASTM C309, Type 1 which are nontoxic and free of taste, odor, and complies with low VOC requirements.
 - b. Where a finish material is to be applied over concrete with architectural finish, provide certification by the product manufacturer stating the curing compound as non-detrimental to the bond of the finish material.
 - c. Ensure curing compound is compatible with future concrete coatings and surface treatments.
 - d. Acceptable manufacturers:
 - 1) Masterkure, BASF The Chemical Company.
 - 2) Kurez DR, Euclid Chemical Company.
 - 3) Or approved equal.
 - I. Clear Curing and Sealing Compound:
 1. Provide a liquid clear curing and sealing compound conforming to the requirements for Type I, Class A, specified in ASTM C1315.
 2. Provide liquid clear curing and sealing compounds which complies with low volatile organic compound (VOC) requirements.
 3. Acceptable manufacturers:
 - a. Kure-N-Seal® 25LV, BASF The Chemical Company.
 - b. Super Diamond Clear VOX, Euclid Chemical Co.
 - c. Approved equal.
 - J. Chemical Hardener:
 1. Chemically reactive solution materials formulated to harden and densify concrete surface.
 - a. Acceptable Manufacturers:
 - 1) Seal Hard; L&M Construction Chemicals, Inc.
 - 2) Euco Diamond Hard; Euclid Chemical
 - 3) Or approved equal.
 - K. Non-Slip (Dry-Shake) Aggregate Surfacers: Aluminum-oxide non-slip aggregate surfacer for dry shake application to fresh concrete.
 1. Acceptable Manufacturers:
 - a. Sikafloor Metal Top 200; SIKA USA
 - b. Spec Plate Floor Topping, Spec Chem
 - c. Or approved equal.
 - L. Epoxy Bonding Compound: A high-modulus, low-viscosity, moisture-insensitive epoxy adhesive having the following properties:

1. Compressive Properties, ASTM D695 at 28 days;
 - a. Compressive Strength: 8,000 psi. min.
 2. Tensile Properties, ASTM D638 at 14 days.
 - a. Tensile Strength: 4,000 psi. min.
 - b. Elongation at Break: One to three percent.
 - c. Modulus of Elasticity: 3×10^5 psi min.
 3. Bond Strength, ASTM C882:
 4. Plastic concrete to hardened concrete at 14 days (moist cure): 1,700 psi. min.
 5. Mixed epoxy resin adhesive shall conform to ASTM C881, Type II, Grade 2, Class C.
 6. Acceptable Manufacturers:
 - a. Sika Corporation; Sikadur 32 Hi-Mod.
 - b. Euclid Chemical Company; Euco Epoxy #452 MV or #620.
 - c. Or approved equal.
- M. Epoxy Adhesive (for grouting dowels): Two-component, high-strength, moisture-tolerant epoxy adhesive:
1. Mixed epoxy resin adhesive shall conform to ASTM C881.
 2. Acceptable Manufacturers:
 - a. Hilti HIT-RE 500 V3, www.hilti.com.
 - b. Simpson XP, www.simpsonanchors.com.
 3. Installation:
 - a. Follow manufacturer's recommendations.
- N. Construction Joint Device: Integral galvanized steel formed to tongue and groove profile for slab-on-grade construction.
1. For exposed concrete areas, provide plastic joint cap strip that can be removed for placement sealant.
 2. Acceptable Manufacturers:
 - a. Heckman Building Products, Inc.
 - b. Or approved equal.
- O. Contraction Joint Insert: Two-piece plastic preassembled preformed contraction joint; depth of embedment equal to $\frac{1}{4}$ of the slab thickness.
1. Acceptable Manufacturers:
 - a. W.R. Meadows: SPEED-E-JOINT®.
 - b. Or approved equal.
- P. Construction and Control Joint Filler for Slab-on-Grade: A two-component epoxy joint filler.
1. Acceptable Manufacturers:
 - a. Sika Corporation: Sikadur 51 Sl.
 - b. Euclid Chemical Company: Euro 700.
 - c. Master Builders: Masterfill® 300.
 - d. Or approved equal.
- Q. Vapor Barrier:
1. Provide black, 3-ply, high-density, polyethylene vapor barrier reinforced with nylon cords and having the following properties:

- a. Classification: ASTM E1745 Class C.
2. Acceptable manufacturers:
 - a. Stego Wrap Vapor Barrier, STEGO Industries, LLC.
 - b. Griffolyn Type 65, Reef Industries, Inc.
 - c. Dura Skrim 8BB, Raven Industries.
 - d. Approved equal.

2.02 MIXES

- A. Selection of Proportions of Normalweight Concrete: ACI 211.1.
- B. Proportions of Ingredients: Establish proportions, including water-cement ratio on the basis of either laboratory trial mixture tests or standard deviation analysis, with the materials specified herein.
 1. Laboratory Trial Mixture Test: ACI 301 and ACI 318.
 2. Standard Deviation Analysis: ACI 301 and ACI 318.
- C. Classes of Concrete:
 1. Class A: 4,500 psi minimum compressive strength at 28 days; 564 pounds per cubic yard minimum cementitious material.
 2. Class B: 3,000 psi minimum compressive strength at 28 days; 517 pounds per cubic yard minimum cementitious material.
 3. Class C: 2,000 psi minimum compressive strength at 28 days; minimum cementitious material per cubic yard in accordance with current ready-mix plant standard practice.
 4. High-Early Strength Concrete: 3500 psi compressive strength at 3 days; 640 pounds per cubic yard minimum cementitious material.
- D. Water-Cementitious Material Ratio:
 1. Class A Concrete shall have a maximum water- cementitious material ratio of 0.45.
 2. Class B Concrete shall have a maximum water- cementitious material ratio of 0.55.
 3. Proportion Class C Concrete to meet the strength requirement.
- E. Slump:
 1. Concrete, at the point of delivery, shall have a slump of 4 inches (± 1 inch) as determined by ASTM C143; slump value may be increased 1 inch for methods of consolidation other than vibration.
 2. Pumped concrete shall have a maximum slump of 5 inches measured prior to pumping.
 3. Concrete containing high-range water-reducing admixture shall have an 8-inch maximum slump after admixture is added to concrete with a 2- to 4-inch slump.
 4. Slump Flow for Self-Consolidating Concrete: Proportion and produce concrete with a slump flow range between 22 inches (minimum) to 28 inches (maximum).

2.03 ADMIXTURES

- A. Air Entraining: Provide air-entrained concrete for each concrete pour except where indicated otherwise on the Drawings or specified herein. Total air content required as follows:
- | | |
|---|-----------------------------------|
| 1. Maximum-size coarse aggregate, inches: | Air content percent by volume(1): |
| $\frac{1}{2}$ | $7 \pm 1\text{-}1/2$ |
| $1\frac{1}{2}$ | $5\text{-}1/2 \pm 1\text{-}1/2$ |
| $3/4$ or 1 | $6 \pm 1\text{-}1/2$ |
- B. Water-Reducing Admixture: Unless high temperatures occur or placing conditions dictate a change, use concrete containing a water-reducing admixture.
- C. Water-Reducing and Retarding Admixture: When high temperatures occur or placing conditions dictate, the water-reducing admixture (Type A) may be replaced with a water-reducing and retarding admixture (Type D). Notify the Contracting Officer of such change and submit product data prior to placement of concrete.
- D. Water-Reducing and Accelerating Admixture: When low temperatures occur or placing conditions dictate, the water-reducing admixture (Type A) can be replaced with a water-reducing and accelerating admixture. Notify the Contracting Officer of such change and submit product data prior to placement of concrete. Water-reducing and accelerating admixture (Type C and E) will not be permitted in concrete for water retaining structures.

2.04 SOURCE QUALITY CONTROL

- A. General Requirements: Provide only Class A concrete in the project except for those cases where indicated otherwise on the Drawings or specified otherwise.
1. Where in-ground encasement of piping is required, provide Class B concrete.
 2. Where in-ground encasement of conduit runs is required, provide Class B concrete.
- B. Use H.E.S. concrete for reaction backings, concrete cradle, and encasement. Provide H.E.S. concrete air entrained with a minimum mix design compressive strength of 3,000 psi at 3 days, and minimum compressive strength of 3,750 psi at 28 days.

PART 3 EXECUTION

3.01 INSPECTION

- A. Inspect work to receive cast-in-place concrete for deficiencies which would prevent proper execution of the finished work. Do not proceed with placing until such deficiencies are corrected to the satisfaction of the Contracting Officer.

3.02 PREPARATION

- A. Joints:
1. Construction Joints: Only the locations of critical joints throughout the structures are indicated on the Drawings. Select additional joint locations in walls, slabs, and beams subject to the Contracting Officer's approval and meeting the following conditions:

- a. Locate such joints to least impair the strength of the structure and near the middle of the span of structural slabs or beams.
 - b. The horizontal length between wall joints shall not exceed 30 feet in a continuous wall. At corners or other intersections of two or more walls, provide a joint in each wall at a distance less than 15 to 20 feet from the intersection point in all directions.
 - c. Space construction joints in structural slabs not greater than 30 feet in each direction, although some adjustments, as approved by the Contracting Officer, may be permitted due to column spacing and details.
 - d. If a beam intersects another beam at a proposed construction joint, offset the joint in the beam a distance equal to twice the width of the beam and provide adequate shear reinforcement as determined by the Contracting Officer.
 - e. Maximum joint spacing for slabs-on-grade shall not be greater than 20 feet.
 - f. Provide waterstops in construction joints where such joints are exposed to liquids, in contact with earth, or subject to weather exposure.
 - g. Place walls and slabs in alternate sections allowing at least two days elapsed time for slabs and five days elapsed time for walls before concrete is placed against an adjacent joint.
 - h. Submit requests for approval of joint locations ten days prior to scheduled concrete pours. Do not make concrete pours unless joint locations have been approved by the Contracting Officer.
 - i. No exceptions permitted to the above requirements unless written approval is given by the Contracting Officer.
2. Expansion Joints and Contraction Joints:
 - a. Install where indicated on the Contract Drawings.
 - b. Do not extend reinforcing or other embedded metal items through expansion and contraction joints except where indicated otherwise on Contract Drawings.
 - c. Sawcutting contraction joints will not be permitted.
 - d. Provide waterstops in joints exposed to liquids, in contact with earth, or subject to weather exposure.
3. When concreting is to be discontinued for more than forty-five (45) minutes and if the construction plane is to be horizontal, install keyways, waterstops and embed dowels in the concrete before initial hardening. Use keyways and dowels in vertical concrete construction only when indicated or directed by the Contracting Officer. Use waterstops for water retaining structures or structures below grade. Horizontal joints are not permitted in slabs or footings.
 - a. Extend dowels placed in joint one splice length into wall and one splice length into next concrete pour.
4. Construction Joints in Elevated (Suspended) Formed Slabs: Placement of additional joint locations shall meet the following:
 - a. Locate such joints to least impair the strength of the structure.
 - b. Space construction joints not greater than 30 feet in each direction, although some deviation from this spacing for column spacing and construction details, as approved by the Contracting Officer, may be permitted. Reinforcement shall continue through construction joint.

- c. Joints shall be located within the third point of slab span. Joints in girders should be offset a minimum distance of two times the width of any intersecting beam.
 - d. Beams, girders, or slabs supported by columns or walls shall not be cast or erected until concrete in the vertical support members is sufficiently hardened to support additional construction loads.
 - e. Where concreting is interrupted long enough for concrete to be hardened, install keyway and embed dowels in the concrete before initial hardening.
 - 1) Place dowels in joint one splice length into slab and one splice length into next concrete pour.
 - 2) Dowel to be spliced with top and bottom reinforcement; size of dowels to match slab reinforcement.
 - 3) Do not "wet stab" dowels into fresh concrete or concrete that has not reached its final set.
 - f. Horizontal construction joints are not permitted in slabs; and are not allowed in beams, unless the joints in the beam are detailed in the structural contract drawings.
5. Control Joints in Slab-on-Grade:
- a. Provide control joint spacing at the following maximum spacing unless noted otherwise:
 - 1) 5 inch slab: 12 feet each way
 - 2) 9 inch slab: 20 feet each way
 - b. Where contraction joint insert is used, press straight edge cutting tool into wet concrete to part aggregate. Place insert into separation until top of insert lays on surface of wet concrete. Remove top section of insert and float concrete to fill voids adjacent to the insert and finish concrete surface.
 - c. Sawcutting is permitted for control joints if denoted on Contract Drawings. Cut concrete as soon as it has hardened sufficiently; complete sawing within 12 hours after placement. Saw a continuous straight slot to a depth of one-quarter the thickness of the slab.
 - 1) When saw cutting a new joint that crosses an existing saw cut joint, provide corner break-out protection for the existing joint.
 - 2) Submit detailed procedure and plans for review and acceptance by the Contracting Officer.
 - d. Fill all control joints with Control Joint Filler.
 - e. Where concreting is interrupted long enough for the placed concrete to harden, construction joint should be provided.
6. Construction Joints in Slabs on Metal Decking: Placement of additional joint locations shall meet the following:
- a. Locate such joints to least impair the strength of the structure.
 - b. Space construction joints not greater than 90 feet in each direction.
 - c. Locate joints that parallel secondary steel floor beams and cross primary steel floor beams near the mid-span of the slab between two adjacent secondary beams and within the end third of the primary beam span.
 - d. Locate joints that parallel primary steel floor beams and cross secondary steel floor beams no closer than 5 feet to the centerline of the primary beam.
 - e. No joint shall occur along length of beam top flange.

7. Bonding to New Concrete: Bond fresh concrete with hardened previously poured new concrete in accordance with the following:
 - a. Roughen and clean hardened concrete of foreign matter and laitance and dampen with water, but with no standing water.
 - b. Cover the hardened concrete with a heavy coating of grout to approximately $\frac{1}{2}$ inch thickness. Use grout of same material composition and proportions of concrete being poured except coarse aggregate omitted. Use grout with a slump of 6 inches minimum.
 - c. Place new concrete on grout before it has attained its initial set.
 - d. Other bonding methods must be approved by Contracting Officer prior to use.
 8. Bonding to Existing Concrete: Roughen existing concrete in the area of bonding to produce exposed aggregate and an absolutely uncontaminated concrete surface.
 - a. Apply Epoxy Bonding Compound over existing prepared concrete in accordance with manufacturer's instructions.
- B. Embedded Items: Pre-position expansion joint materials, anchors, and other embedded items in advance of new concrete pours.
1. Embedded Pipes and Conduits: Material not harmful to concrete may be permitted to be embedded in concrete upon approval by the Contracting Officer. Items embedded shall satisfy the following:
 - a. Maximum outside dimension not greater than one-third the overall thickness of the member in which it is embedded.
 - b. Minimum spacing between items not less than 3 widths on center nor 3 inches clear between items.
 - c. Item shall not impair strength of member.
 - d. Provide 2-inch minimum clearance to face of slab.
 - e. Cutting, bending, or displacement of reinforcement will not be allowed.
 - f. The item(s) to be embedded shall not cross expansion joints within the slab depth.
 - g. The item(s) to be embedded shall not be made of aluminum.
 2. Anchor Rod Placement:
 - a. Install anchor rods accurately, vertically and horizontally, in the formwork as shown on the Contract Drawings.
 - b. Ensure rods are firmly held in the correct position and elevation by suitable templates during placement of concrete.
 - c. The variation in location of anchor rods and other embedded items from the dimensions shown on the Contract Drawings shall meet the tolerances listed in AISC 303: "Code of Standard Practice for Steel Buildings and Bridges".
- C. Anchoring Reinforcement Dowels into Existing Concrete:
1. Drill holes for each dowel to the size and depth indicated on the Drawings with carbide tip bit or star bit. Core drilling will not be permitted. Do not drill into or cut or otherwise damage existing reinforcement bars. If existing reinforcement bars are encountered during the drilling operation, relocate the hole to clear the existing reinforcement as directed by the Contracting Officer.
 2. Blow clean each finished hole with an oil free air jet and then flush with a jet of clean water.

3. Immediately prior to the grouting operation, remove all water from the hole and from the walls of the hole.
4. Pump dispensing gun for proper mixture. Insert nozzle and pump epoxy adhesive into the hole and insert reinforcement dowels. Do not retemper grout that has begun to stiffen; discard such grout.
5. Plug unused holes as directed by the Contracting Officer.

D. Installation of Vapor Barriers

1. General: Extend vapor barriers to extremities of areas to be protected from vapor transmission.
 - a. Ensure base material, upon which vapor barrier is placed, is level and compacted.
 - b. Installation shall be in accordance with manufacturer's instructions and ASTM E1643.
 - c. Coordinate vapor barrier placement with the installation of perimeter foundation insulation.
2. Installation of under slab vapor barriers:
 - a. Install vapor barrier under slab on grade areas where specified on the contract drawings.
 - b. Unroll vapor barrier with the longest dimension parallel with the direction of the concrete pour.
 - c. Lap vapor barrier over footings and seal to foundation walls.
 - d. Overlap vapor barrier sides 6 inches and ends 12 inches; seal with manufacturer's tape.
 - e. Seal all penetrations (including pipes) per manufacturer's instructions.
 - f. No penetration of the vapor barrier shall be allowed except for reinforcing steel and permanent utilities.
 - g. Repair damaged areas immediately before concealment by other work by cutting patches of vapor barrier and overlapping damaged area 6 inches; tape all four sides.

3.03 CONSTRUCTION

A. Construction of Concrete Elements:

1. Construct the concrete elements indicated on the Contract Drawings or in the specifications; including but not limited to beams, columns, slabs, foundations, in-ground encasement of piping and conduit, reaction backings for piping, concrete backfill, and the reinforced concrete bases for equipment and piping provided under this contract.
2. Provide only Class A concrete in the project except for those cases where indicated otherwise on the Drawings or specified otherwise.
 - a. Where in-ground encasement of piping is required, provide Class B concrete
 - 1) Encase pipes under structures and buildings or where indicated on the Contract Drawings; encase in concrete for the full length of the pipe run under the structure and as indicated.
 - b. Where in-ground encasement of conduit runs is required, provide Class B concrete.
 - 1) Encase conduit runs indicated on the Contract Drawings.

- c. Provide Class B concrete for backfilling of overexcavated foundation area, foundation voids, and cavities.
- B. Production of Concrete
 - 1. Ready-Mixed Concrete:
 - a. Batched, mixed and transported in accordance with ASTM C94.
 - b. Add admixtures to the mix in accordance with ACI 301.
 - c. Plant equipment and facilities conforming to the "Check List for Certification of Ready Mixed Concrete Production Facilities" of the National Ready Mixed Concrete Association.
- C. Mix, place, and cure H.E.S. concrete as specified in **PENNDOT Section 704** and **PENNDOT Section 1001**.
- D. Placing
 - 1. General: Conduct placement work in accordance with ACI 304R and such additional requirements as specified herein.
 - a. Complete discharge of the concrete within 1½ hours or before the mixing drum has revolved 300 revolutions, whichever comes first, after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates.
 - 2. Preparation:
 - a. Prepare formwork in advance and remove snow, ice, water, and debris from within forms.
 - b. Pre-position reinforcement in advance of concrete pours.
 - c. Pre-position waterstops, expansion joint materials, anchors, and embedded items in advance of concrete pours.
 - d. Sprinkle subgrades sufficiently to eliminate water loss from concrete in accordance with ACI 301 Chapter 11.
 - e. Do not place concrete on frozen surfaces.
 - 3. Conveying:
 - a. Handle concrete from mixer to final deposit rapidly by methods which will prevent segregation or loss of ingredients to maintain required quality of concrete.
 - b. Do not convey concrete through aluminum or aluminum alloy.
 - c. Do not place concrete by pumps or other similar devices without prior written approval of the Contracting Officer.
 - d. Placing concrete by pumping methods shall conform to the applicable requirements of ACI 304R, Chapter 9, and ACI 304.2R.
 - 4. Depositing:
 - a. Do not drop concrete freely where reinforcing will cause segregation, nor more than four (4) feet.
 - b. Deposit concrete in approximately horizontal layers of 12 to 18 inches.
 - c. Do not allow concrete to flow laterally more than three feet.
 - d. Place concrete at such a rate that concrete which is being integrated with fresh concrete is still plastic.
 - e. Do not deposit concrete on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within sections.

- f. Do not use concrete which has partially hardened or has been contaminated by foreign materials.
 - g. Do not subject concrete to procedures which will cause segregation.
 - h. Do not place concrete in forms containing standing water.
 - i. Make placement within sections continuously to produce monolithic unit.
 - j. Do not begin placement of concrete in beams or slabs until concrete previously placed in walls or columns have attained initial set.
 - k. Do not bend reinforcement out of position when placing concrete.
5. Consolidation:
- a. Consolidate concrete by vibration, spading, rodding, or other manual methods. Work concrete around reinforcement, embedded items and into corners; eliminate all air or stone pockets and other causes of honeycombing, pitting, or planes of weakness.
 - b. Use vibration equipment of internal type and not the type attached to forms and reinforcement.
 - c. Use vibrators capable of transmitting vibration to concrete in frequencies sufficient to provide satisfactory consolidation.
 - d. Do not leave vibrators in one spot long enough to cause segregation. Remove concrete segregated by vibrator operation.
 - e. Do not use vibrators to spread concrete.
 - f. Have sufficient reserve vibration equipment to guard against shutdown of work occasioned by failure of equipment in operation.
6. Cold Weather Concreting: Perform cold weather concrete work in accordance with ACI 306R and the following additional requirements.
- a. Provide concrete delivered at the job-site in accordance with the following temperature limitations:

Air Temperature Deg. F	Minimum Concrete Temperature, deg F	
	For sections with least dimension less than 12 in.	For sections with least dimension 12 in or greater
30 to 45	60	55
0 to 30	65	60

- b. Provide equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather.
- c. Maintain concrete at temperatures listed in Table 5.1 of ACI 306R as follows, after the concrete has developed a compressive strength of 500 psi:
 - 1) slab-on-grade: 5 days.
 - 2) walls and supported slabs: 10 days.
- d. If the strength is not achieved, maintain the minimum temperature an additional 24 hours or until the 500 psi strength is reached.
- e. Make additional concrete cylinders to verify strength achievement of 500 psi; however, additional cylinders are not required for every pour, provided concrete temperatures are maintained fairly uniform. Once two sets of cylinders have been broken and a strength of 500 psi is achieved, additional

- cylinders will not be required, except for random testing as determined by the Contracting Officer.
- f. Remove temperature protection after 500 psi is achieved, but in a manner so thermal shock does not occur to the exposed concrete. The removal criteria shall be as stated in ACI 306R.
 - g. Leave housing, covering, or other protection used in curing intact at least 24 hours after artificial heating is discontinued.
 - h. Surfaces with which the concrete is to come in contact must be free of frost, snow and ice. Subgrade shall be free of frost. Do not place concrete around any embedment which has a temperature below freezing.
 - i. If water or aggregate is heated above 100 degrees F, combine water with aggregate in the mixer before cement is added. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 100 degrees F.
 - j. Provide equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather. Do not use foreign materials or materials containing snow or ice.
 - k. Surfaces with which the concrete is to come in contact with must be free of frost, snow to and ice.
7. Hot Weather Concreting: Perform hot weather concrete work in accordance with ACI 305R and the following additional requirements.
- a. Temperature of concrete delivered at the job-site shall not exceed 90 degrees F.
 - b. Cool ingredients before mixing to prevent temperature in excess of 90 degrees F.
 - c. Make provisions for windbreaks, shading, fog spraying, sprinkling or wet cover when necessary.
- E. Finishing:
1. General: Finish concrete in the various specified manners either to remain as natural concrete or to receive an additional applied finish or material.
 - a. Concrete containing ground granulated blast furnace slag material may have longer time of set compared to 100 percent Portland Cement concrete.
 2. Formed Surfaces: Provide one or more of the following finishes to the surfaces of the concrete after removal of forms. The locations where these finishes are required are listed herein or specified on the Drawings. Allowable surface irregularities are designed as either "abrupt" or "gradual." Check gradual irregularities using 10 foot straightedges per ACI 117 Specification for Tolerances for Concrete Construction and Materials and Commentary.
 - a. "Rough Form" finish: Surface may include roughness and irregularities not to exceed ½ inch, but tie holes and defects shall be patched.
 - b. "Ordinary Wall" finish: Surface that is true and uniform without any conspicuous offsets or bulges. Gradual irregularities not to exceed ½ inch and abrupt irregularities not to exceed 1/4 inch.
 - c. "Plywood" finish: Similar to the ordinary wall finish. Construct the surface of the forms using 5/8-inch plywood or boards lined with tempered hardboard not less than 3/16 inch thick. Place the plywood or liner sheets in an orderly

and symmetrical arrangement using sheets as large as practicable. Do not use sheets showing torn grain, worn edges, patches of holes from previous use, or other defects which will impair the texture of the concrete surfaces. Remove gradual irregularities exceeding $\frac{1}{2}$ inch and abrupt irregularities exceeding $\frac{1}{8}$ inch. Completely remove all fins on the surface. Rub all surfaces which cannot meet these requirements.

- d. "Rubbed" finish: Apply to a freshly hardened "plywood" finish. Complete rubbing within one day of removal of forms. Wet surfaces and rub with a carborundum brick or other abrasive until all form marks, projections, and irregularities have been removed and a smooth uniform surface, texture, and color are produced. Wash the surface clean after rubbing.
3. Unformed Surfaces: In concrete having unformed surfaces, use just sufficient mortar to avoid the necessity for excessive floating. Slope exposed unformed surfaces to provide quick, positive drainage and to avoid puddles in low spots. Unless otherwise noted, set floor drains $\frac{1}{2}$ inch below the normal floor elevation and slope floor toward the drain. Slope all surfaces exposed to weather $\frac{1}{4}$ inch per foot for drainage unless noted otherwise on Drawings.
 - a. "Floated" Finish: After concrete has been placed, consolidated, struck off, and leveled, do not work further until ready for floating. Begin floating when water sheen has disappeared and when the surface has stiffened sufficiently to permit the operation. During or after first floating, check planeness of surface with a ten foot straightedge applied at not less than two different angles. Cut down high spots and fill low spots during this procedure to produce a surface with true planes within $\frac{1}{4}$ inch in ten feet as determined by a ten foot straightedge placed anywhere on the slab in any direction. Following straightedge checking, refloat slab immediately to a uniform sandy texture.
 - b. "Steel Trowel" Finish: Obtained by working a floated finish with a steel trowel. First troweling shall produce a smooth surface which is relatively free of defects but which may still show some trowel marks. Perform additional trowelings by hand after the surface has hardened sufficiently. Perform final troweling when a ringing sound is produced as the trowel is moved over the surface. Thoroughly consolidate surface by hand trowel operations. Produce finished surface essentially free of trowel marks, uniform in texture and appearance, with true planes within $\frac{1}{4}$ inch in ten feet, as determined by a ten foot straightedge placed anywhere on the slab in any direction.
 - c. "Broom or Belt" Finish: Immediately after concrete has received a floated finish, give surface a coarse transverse scored texture by drawing a broom or burlap across the surface.
 - d. "Nonslip" Finish: The surfaces shall be given a "dry shake" application of non-slip aggregate surfacer. The rate of application of such material not to be less than 25 pounds per 100 square feet. Apply in accordance with manufacturer's recommendations.
 - e. Floor Flatness/Levelness Tolerances:

- 1) F_f (Flatness F-Number) defines relative smoothness of a floor slab; F_L (Levelness F-Number) defines relative conformity of floor surface to horizontal plane.
 - 2) Floor tolerance measurements (F_f and F_L) shall be tested in accordance with ASTM E1155.
 - 3) Overall F_f and F_L Numbers represent test surface defined as total floor area of one building level.
 - 4) Local F_f and F_L Numbers represent a test section within the concrete pour. Each test section shall not exceed 2,500 square feet.
 - 5) Floor Overall F-Numbers shall conform to the following floor surface classifications defined in ACI 117:
 - a) Mechanical and Electrical areas, slab surface under raised floors: Moderately Flat - $SOF_f 25 / SOF_L 20$.
 - b) Area not defined above: Flat - $SOF_f 35 / SOF_L 25$.
 - 6) Minimum Local F-Number tolerances shall be $\frac{2}{3}$ of specified Overall F-Number tolerances.
 - 7) F_L (Levelness F-Number) does not apply to unshored steel framed construction. The floor slab shall be constructed to meet the following tolerance:
 - a) Allowable variations from top of slab elevations identified on Contract Drawings: Plus/minus $\frac{3}{8}$ inch.
 - 8) Floor tolerance compliance tests shall be performed within 24 hours after placement and reported to Construction Manager within 72 hours.
4. Special Finishes:
- a. Deck Finish: Power or single hand troweling of slab surface followed by a light hair broom drawn across the slab to produce fine shallow scored texture.
 - b. Architectural Finishes. Special finishes such as Vinyl Composition Tile, Quarry Tile, Ceramic Tile, or other, when used, shall be as specified herein or on the Drawings.
5. Application for Finishes: Except where the type of finish is indicated on the drawings or under "Special Finish," all concrete surfaces shall be finished as indicated below.
- a. "Rough Form" Finish:
 - 1) All surfaces to be covered by earth and not exposed to view.
 - b. "Ordinary Wall" Finish:
 - 1) Interior and exterior wall and slab surfaces not exposed to view.
 - 2) Inside vertical surfaces of tank type structures below an elevation which is 18 inches below normal water surface.
 - 3) Interior walls of filters below an elevation which is 6 inches below the filter media.
 - 4) All wall and overhead surfaces or clearwells.
 - 5) Undersides of slabs which will be covered by architectural ceilings.
 - c. "Plywood" Finish:
 - 1) All surfaces to be painted.
 - d. "Rubbed" Finish:
 - 1) All interior and exterior surfaces exposed to view which are not to be painted.
 - 2) All exterior surfaces to a point 6 inches below finished ground.
 - 3) Inside vertical surfaces of tank type structures above an elevation which is 18 inches below normal water surface.
 - 4) Interior walls of filters to a point 6 inches below filter media.
 - 5) Equipment pads, pipe supports, etc.
 - e. "Floated" Finish:
 - 1) All unformed surfaces unless otherwise specified.
 - f. "Steel Trowel" Finish:

- 1) Interior floors of structures except where Architectural Finish is to be applied.
 - 2) Interior stair treads.
 - 3) Tops of exposed walls.
 - 4) Floors of clearwells and basins.
- g. "Broom or Belt" Finish:
 - 1) Sidewalks, exterior ramps and platforms.
 - 2) Unloading dock platform.
 - 3) Walkways on the process tanks.
- h. "Nonslip" Finish:
 - 1) Exterior stair treads and landings.
- i. Architectural Finishes:
 - 1) As specifically called for in these Specifications or on the Drawings.
6. Application of Chemical Hardener: Apply to floor surfaces as scheduled on Drawings. Concrete must be a minimum of twenty-eight (28) days old and cured by water or sheet material curing methods.
 - a. Concrete surfaces must be clean, dry, and free of residues, oil, wax, sealers, curing compounds, laitance, or other contaminants in order to promote maximum penetration of hardener.
 - b. Apply hardener in two applications in accordance with hardener manufacturer's instructions and by such methods as stated in instructions.
 - c. Application: Mechanical scrubbers, equipped with brushes, are the preferred method of application for the first coat.
 - d. Pour chemical hardener directly from the container onto the surface to be treated, maintaining an application rate of 200 ft.² per gallon. Scrub chemical hardener into the surface for 15-20 minutes, working all areas evenly.
 - e. Apply second coat using sprayers or rollers in accordance with manufacturer's instructions.

3.04 CURING AND PROTECTION

- A. General: Immediately after placement and finishing, protect concrete from premature drying, excessive hot or cold temperatures and mechanical injury. Perform curing by water curing, sheet form curing, or liquid membrane forming methods in accordance with ACI 308. Cure concrete continuously for a minimum of seven days at ambient temperatures above 40° F.
- B. Hot Weather Curing: See Hot Weather Concreting this Section.
- C. Cold Weather Curing: See Cold Weather Concreting this Section.
- D. Application of Liquid Curing Compound:
 1. Finishing operations must be completed prior to application. Apply compound as soon as the free water on the surface disappears and no water sheen is visible. Surface shall be capable of taking walking workmen without being marred. Apply compound in two (2) applications.
 2. Do not apply curing compound to construction joint surfaces. Protect exposed reinforcement during application of curing compound. Water cure those areas not coated with compound.
 3. Do not use liquid curing compound when the ambient air temperature during placement and for 24 hours after placement is or will fall below 35 degrees F.

4. Do not use liquid curing compounds on concrete surfaces which will receive later treatments, such as hardeners, special finishes, protective coating, dampproofing, waterproofing, future grout, grout fill, or coatings.
- E. Curing of surfaces to receive Membrane Waterproofing shall be controlled by water fog spraying, water damped coverings, and/or impermeable sheet film cover for the full 7-day period specified above. All concrete surfaces shall have a minimum cure of 28 days before application of the membrane. The use of liquid membrane-forming curing compounds on these surfaces is prohibited.
- F. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.
- G. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.
- H. High-early strength concrete shall be maintained at 50° F and in a moist condition for at least the first three (3) days.

3.05 FIELD QUALITY CONTROL

- A. Testing and Inspection:
 1. During the period when concrete is being placed, the Approved Agency must perform routine and other testing of materials.
 - a. Advise the Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. Provide and maintain adequate and separate facilities for safe storage and proper curing of concrete test cylinders on the Work Site for the sole use of the Approved Agency.
 - c. Strength testing requirements are based on using 6-inch by 12-inch size cylinders.
 - d. Provide containers for transporting concrete test cylinders to the testing laboratory.
 - e. The Approved Agency will perform additional materials testing due to change in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - f. Failure of the Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered.
 2. The Independent Testing Laboratory shall:
 - a. Obtain composite samples in accordance with ASTM C172.
 - b. Mold and cure minimum of five test specimens for each strength test in accordance with ASTM C31 and as follows:
 - 1) Concrete compression test: Use standard 6 inch x 12 inch cylinders.
 - 2) Concrete flexural strength: Use 6 inch x 6 inch x 12 inch beams.
 - 3) Identify each test by number, mix, amount of admixture, origin of sample in the structure, the date the test specimen was made, the date the test specimen was tested, the amount of slump determined, and the compressive and flexural strength test results.
 - 4) Test Methods:
 - a) Compressive strength test: ASTM C39.

- b) Flexural strength test: ASTM C78 ((Required only for slabs-on-grade subject to wheel loads)).
 - c) Test one specimen at 7 days for information and test two specimens at 28 days for acceptance. A strength test is the average of the strengths of the two cylinders tested at 28 days. Keep two spare or break at 56 days for acceptance (per direction of the Contracting Officer)
 - d) Perform one strength test at the start of each day/pour and for each 100 cubic yards of concrete poured or not less than once for each 3,300 square feet of area placed, but not less than one test for each structure.
 - c. Make slump tests for each truck load upon truck arrival at the job-site and whenever consistency of concrete appears to vary in accordance with ASTM C143.
 - d. Make air content tests for each truck load upon truck arrival at the job-site in accordance with ASTM C231 or ASTM C173.
 - e. Prepare and submit all reports required in the various standards and specifications referenced herein.
 - 1) Distribution of reports shall be:
 - a) Two copies to the Contracting Officer.
 - b) One or more copies, as required, to the Contractor.
 - f. Immediately notify the Contractor and the Contracting Officer of any test results which do not conform to the Specification requirements.
- B. Evaluation and Acceptance:
- 1. The strength level of the concrete will be considered satisfactory if the averages of all sets of three consecutive strength tests equal or exceed specified strength and no individual strength test result is below specified strength by more than 500 psi.
 - 2. If the concrete fails to meet the specified strength requirements the Contracting Officer may require one or both of the following:
 - a. The Contracting Officer shall have the right to order a change in the mix proportions for the remaining concrete being poured.
 - b. The Contracting Officer may order tests on the in-place concrete. Testing shall be in accordance with ACI 301 at no increase in contract price.
 - 3. Concrete Strength Test for Concrete in Place:
 - a. The Contracting Officer will determine locations where the concrete in place is potentially deficient, and where to obtain test cores to least impair the structure's strength.
 - 1) As an aid to evaluate in place concrete strength or for selecting areas to be cored, the Contracting Officer may permit concrete in place to be tested by impact hammer, sonoscope, or other non-destructive device to determine the relative strengths at various locations in the structure.
 - 2) The preliminary non-destructive tests of concrete in place will not be used as a basis for accepting or rejecting the concrete; rather the core testing will be the basis for accepting or rejecting the in-place concrete.
 - b. Concrete Core Test:
 - 1) Test Procedure:
 - a) The Contracting Officer will determine the locations in each member or area of concrete in place where the required cores may be obtained.
 - b) At least 3 representative core samples will be taken from each member or area of concrete in place that is considered potentially deficient.
 - (1) Each core sample will be at least 3 inches in diameter.

- (2) If the concrete in the structure will be dry under service conditions, the cores will be air dried for 7 days before the test at a temperature of 60° F to 80° F and a relative humidity of less than 60 percent; the cores will be tested dry.
 - (3) If the concrete in the structure will be more than superficially wet under service conditions, the cores will be tested after moisture conditioning them in accordance with ASTM C42/ C42M.
 - c) The core samples will be tested in accordance with ASTM C42/ C42M.
 - (1) If one or more of the cores shows evidence of having been damaged before the testing, it must be replaced either subsequent to or during its removal from the structure.
 - d) Solidly fill core holes with low slump concrete.
- 2) Acceptance Criteria:
 - a) Concrete in the area represented by a core test will be considered adequate if the average compressive strength of the cores is equal to at least 85 percent of the specified strength f'_c , and if no single core is less than 75 percent of the specified strength f'_c .
 - b) If the core tests fail to demonstrate concrete strengths adequate for the intended purpose of the member or members in question, or are inconclusive or impractical to obtain, or if structural analysis does not confirm the safety of the structure, load tests may be required.
- 4. The results will be evaluated in accordance with ACI 318/318R

3.06 REPAIR OF DEFECTIVE CONCRETE

A. Defective Concrete

- 1. Porous areas, open or porous construction joints, and honeycombed concrete will be considered to indicate that the requirements for mixing, placing and handling have not been complied with and will be sufficient cause for rejection of the members of the structure thus affected.
- 2. Defective work exposed upon removal of forms shall be entirely removed or repaired within forty-eight hours after forms have been removed.
- 3. Repaired areas will not be accepted if:
 - a. The structural requirements have been impaired by reducing the net section of compression members.
 - b. The bond between the steel and concrete has been reduced.
 - c. The area is not finished to conform in every respect to the texture, contour, and color of the surrounding concrete.
- 4. If the above requirements are not satisfied or if there are excessive honeycombs or other defects, the Contracting Officer may require that the members of unit involved be entirely removed and satisfactorily replaced at no additional expense to the Government.
- 5. The Contracting Officer will determine the extent and manner of action to be taken for the correction of defective concrete as may be revealed by surface defects or otherwise.
 - a. Prior to repairing structural defects or defects which impair watertightness (shrinkage cracks, etc.), submit proposed material and repair methods to the Contracting Officer for approval.
- 6. As soon as the forms have been stripped and the concrete surfaces exposed, remove fins and other projections, fill recesses left by the removal of form ties, and repair surface defects which do not impair structural strength. Clean all

- exposed concrete surfaces and adjoining work stained by leakage of concrete to the satisfaction of the Contracting Officer.
7. Hammer pack tie holes and other small cavities with a stiff mortar of the same material, but somewhat leaner than that in the concrete. Clean the cavity and the area wetted before mortar is placed.
 8. Repair and patch defective areas with cement mortar of mix proportions and materials identical to those used in the surrounding concrete. Produce a finish on the patch that is indistinguishable from the surrounding concrete.
 9. Where the honeycomb or voids are not excessive and repairs are authorized by the Contracting Officer, chip out the defective areas in a square shape to sound solid concrete with a depth not less than 2 inches. Make edges of cuts perpendicular to concrete surface or slightly undercut to provide a key at the edge of the patch. Before placing cement mortar, thoroughly clean, dampen, and brush coat area to be patched with neat cement grout. Other patching materials may be used if accepted by Contracting Officer in writing prior to start of repair work. The patch should be kept damp for seven days at a temperature above 50°F.
 10. Concrete Compressive Strength:
 - a. If concrete fails to meet the minimum specified compressive strength test requirements, the concrete represented by such tests will be considered questionable and subject to further testing and other requirements as follows:
 - 1) Additional curing may be required as directed by the Contracting Officer.
 - 2) Modifications may be required for remaining concrete work, including changes in the concrete mix designs.
 - 3) When the strength of the structure is considered potentially deficient, structural analysis and/or additional testing may be required.
 - a) If in the opinion of the Contracting Officer there is cause for concern over the adequacy of the structure regardless of the results of any previous tests, additional tests of the hardened concrete may be required.
 - (1) The additional testing of questionable concrete will be conducted in accordance with the requirements of ASTM C42/ C42M.
 - (2) If the initial test acceptance requirements had been met, the Contractor is not required to bear the costs of such additional tests unless their results confirm that the concrete in place is deficient.
 11. Concrete Appearance:
 - a. Repair defects which adversely affect the appearance of the specified finish in concrete exposed to view if possible.
 - 1) If in the opinion of the Contracting Officer the defect cannot be repaired, the concrete may be accepted or rejected as provided in this Section.
 - 2) Concrete not exposed to view is not subject to rejection for defective appearance.
 12. Location of Members:
 - a. Concrete members cast in the wrong location may be rejected if the strength, appearance, or function of the structure is adversely affected; or if the misplaced items interfere with other construction.
 13. Dimensional Tolerances:
 - a. Inaccurately formed concrete surfaces which are exposed to view and do not conform to the requirements of ACI 117/117R may be rejected.
 - 1) Repair, or remove and replace, the section as required.

- 2) If the outlines of formed concrete surfaces are smaller than required by an amount exceeding the requirements of ACI 117/117R, they will be considered deficient in strength.
- 3) If the outlines of formed concrete surfaces are larger than required by an amount exceeding the requirements of ACI 117/117R, they may be rejected.
 - a) The Contracting Officer may require that the excess material be removed.
 - b) If the excess material is to be removed, do so in a manner that maintains the strength of the section and meets the other applicable requirements of function and appearance.

3.07 CLEANING

- A. At the end of each day, clean and remove waste sandblasting material from the Work area.

3.08 ATTACHMENTS

- A. The following attachments are appended to this Section following the "END OF SECTION" marker:
 1. Final Concrete Mix Design Submittal Form.
 2. Test Results Submittal Form.

END OF SECTION

FINAL CONCRETE MIX DESIGN SUBMITTAL FORM

(One for each required mix design)

PROJECT: _____ Location: _____
 General Contractor: _____
 Mix design no.: _____ Design strength: _____

USE (Describe *): _____

Mix Design Preparation: Based on Standard Deviation Analysis: _____
 (check one) or Based on Trial Mixture Test Data: _____

MATERIALS:

Aggregates: (Provide size, type, source, specification)

Coarse: _____

Fine: _____

Cement Type/Source: _____

Admixtures: (Provide product, manufacturer)

Water Reducer: _____

Air Entraining: _____

Accelerator: _____

Other: _____

CONCRETE PROPERTIES

Water/Cementitious Material Ratio: _____

Slump: _____ inches

Entrained Air: _____ %

Density _____ pcf

SPECIFIC GRAVITIES

Fine Aggregate _____

Coarse Aggregate: _____

ADMIXTURES

Accelerator _____ oz. per 100# cement

W. R. _____ oz. per 100# cement

A. E. _____ oz. per 100# cement

Other _____ oz. per 100# cement

MIX PROPORTIONS

	Volume	Weight	Absolute
	(cubic feet)	(lbs)	

Cementitious Material:	_____	_____	_____

Fine ** Aggregate:	_____	_____	_____

Coarse ** Aggregate:	_____	_____	_____

Water:	_____	_____	_____

Entrained Air:	_____	_____	_____

Other:	_____	_____	_____

TOTAL: _____

TEST RESULTS SUBMITTAL FORM

METHOD 1 - STANDARD DEVIATION ANALYSIS (ACI 318 Chapter 5):

Number of Test Cylinders Evaluated: _____ Standard Deviation: _____

(Attach Copy of All Test Results)

Mix Designs Proportioned to Achieve Both of the Following:

$$f'_{cr} = f'_c + 1.34s = \text{_____} \text{ psi}$$

$$f'_{cr} = f'_c + 2.33s - 500 = \text{_____} \text{ psi}$$

$$\text{Actual } f'_c = \text{_____} \text{ psi } (\leq f'_{cr})$$

$$\text{Slump} = \text{_____} \text{ in.} \quad \text{Air Content} = \text{_____} \%$$

METHOD 2 - TRIAL MIXTURE TEST DATA (ACI 318 Chapter 5):

Age (days)	Mix 1 (comp. str.)	Mix 2 (comp. str.)	Mix 3 (comp. str.)
7	_____	_____	_____
28	_____	_____	_____
28	_____	_____	_____
28 day avg.	_____	_____	_____

Mix Design Proportioned to Achieve the Following:

$$\begin{aligned} & f'_{cr} = f'_c + 1200 \text{ psi (for } f'_c \leq 5000 \text{ psi)} \\ \text{or} \quad & f'_{cr} = 1.1f'_c + 700 \text{ psi (for } f'_c > 5000 \text{ psi)} \end{aligned}$$

$$\text{Slump} = \text{_____} \text{ in.} \quad \text{Air Content} = \text{_____} \%$$

REMARKS: _____

Note: Fill in all blank spaces. Use -0- (zero) or N.A. (not applicable). See Design and Control of Concrete Mixtures, Portland Cement Association, for assistance in filling out this form.

SUBMITTED BY:

Ready-Mix Supplier: Name _____

Address: _____

Phone Number: _____

**SECTION 036000
GROUT****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. This section covers the furnishing and placing of grout as specified on the drawings and in various other sections of these specifications.

1.02 RELATED SECTIONS

- A. Section 033000: Cast-in-Place Concrete.

1.03 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO M6: Standard Specification for Fine Aggregate for Hydraulic Cement Concrete.
- B. American Concrete Institute (ACI):
 - 1. ACI 305R: Guide to Hot Weather Concreting.
 - 2. ACI 306R: Guide to Cold Weather Concreting.
 - 3. ACI 306.1: Standard Specification for Cold Weather Concreting.
 - 4. ACI 308: Standard Practice for Curing Concrete.
 - 5. ACI 351.1R: Grouting between Foundations and Bases for Support of Equipment and Machinery.
- C. ASTM International (ASTM):
 - 1. ASTM C33: Standard Specification for Concrete Aggregates.
 - 2. ASTM C109: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. [50-mm] Cube Specimens).
 - 3. ASTM C150: Standard Specification for Portland Cement.
 - 4. ASTM C827: Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
 - 5. ASTM C1090: Standard Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout.
 - 6. ASTM C1107: Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following for approval:
 - a. Product Data:
 - 1) Non-shrink metallic grout.
 - 2) Non-shrink non-metallic grout.
 - b. Certificates:
 - 1) Grout manufacturer non-shrink certification.
- B. Informational Submittals:
 - 1. Submit the following for information:
 - a. Manufacturer's Instructions:
 - 1) Manufacturer's placing instructions.

1.05 QUALITY REQUIREMENTS

- A. Non-Shrink Grout Performance Qualifications: Furnish the grout manufacturer's current independent laboratory test results indicating the grout conforms to the following:
 - 1. Early height change of 0.0% to 4.0%, according to ASTM C827.
 - 2. Hardened height change of 0.0% to 0.3% according to ASTM C1090.
 - 3. Compressive strength of 4,000 psi strength developed with a trowelable mix within 24 hours when tested in accordance with the requirements of ASTM C109 modified in accordance with the requirements of ASTM C1107.
 - 4. Placement time based on initial set of not less than 60 minutes at 70° F.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Provide protective covering over materials to prevent moisture damage and contamination of grout materials.
- B. Store and pre-condition grout and grout materials in accordance with the grout manufacturer's requirements. Provide air-conditioned storage if required.
- C. Store grout materials in undamaged condition with seals and labels intact as packaged by the manufacturer.

1.07 PROJECT CONDITIONS

- A. Environmental Requirements: Protect against high and low temperatures and unfavorable environmental conditions in accordance with American Concrete Institute standards for placement of concrete (ACI 305R, 306R, and 306.1).

PART 2 PRODUCTS

2.01 MATERIALS

- A. Non-Shrink Non-Metallic Grout:
 - 1. A factory-premixed material containing no corrosive irons, aluminums, chemicals, or gypsums meeting ASTM C1107 Grades A, B, and C.
 - a. Provide a ready-mix type of grout requiring only the addition of water.
 - b. Do not add other materials to the grout.
 - c. Provide grout manufactured using Type I (Normal) cement as specified in Subparagraph 2.01C this specification.
 - 2. Acceptable manufacturers for non-shrink non-metallic grout include the following:
 - a. Five Star Products, Inc.
 - b. Euclid Chemical Company.
 - c. Or approved equal.
- B. Portland Cement:
 - 1. Portland Cement conforming to the requirements of ASTM C150 Type I
- C. Aggregates:
 - 1. Fine aggregate conforming to the material quality requirements of ASTM C33.

2.02 MIXES

- A. Non-Shrink Grout: Use ready-mix type requiring only the addition of water. Do not add other materials. Water requirement proportions shall conform to manufacturer's specifications for the desired mix consistency.

PART 3 EXECUTION

3.01 PREPARATION

- A. Preparation of Surface:
 - 1. Normal Grout: Clean areas to be grouted free of oil, grease, laitance, dirt, and other contaminants. Remove loose material. Remove rust, paint, and oil from metal components in contact with grout.
 - 2. Non-Shrink Grout: Prepare in accordance with manufacturer's printed instructions.
- B. Forming:
 - 1. Use forming procedures that allow proper and complete placement of grout.
 - 2. Anchor support elements so no movement is possible.
 - 3. Remove supports only after grout has hardened.
 - 4. Pre-treat wood forms that may absorb moisture with forming oils.
- C. Grout Mixing: Use power-operated mechanical mixer of sufficient capacity to carry out batch mixing without interruption.
 - 1. Mix Non-Shrink Grout in accordance with manufacturer's instructions.
 - 2. Mix grout (sand/cement) in accordance with requirements specified for concrete under Section 03 30 00.

3.02 INSTALLATION

- A. Grout (Sand/Cement): For grouting applications, place and cure grout as follows:
 - 1. Following surface preparation, saturate the concrete with water; then remove excess water and brush on a coat of neat cement. Place grout while neat cement is wet.
 - 2. Place grout in a single pour. Straight-edge exposed grout surface for trueness; consolidate and finish with a steel trowel.
 - 3. Cure and seal in accordance with ACI 308.
 - 4. In vertical applications, place grout in monolithic pours.
- B. Non-Shrink Metallic Grout: Place in unexposed areas or exposed areas where grouting or equipment is subject to heavy vibratory forces. Place in accordance with manufacturer's instructions.
- C. Non-Shrink Non-Metallic Grout: Perform grout placement in accordance with the recommendations of ACI and the manufacturer's published specification for mixing and placing. Place non-shrink non-metallic grout only where indicated on Drawings.

3.03 SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. During the period when grout is being placed, the Testing and Inspection Agency (Approved Agency) must perform routine and other testing of materials.
 - a. Advise the Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. Provide and maintain adequate and separate facilities for safe storage and proper curing of grout test samples on the Work Site for the sole use of the Approved Agency.
 - c. Provide containers for transporting grout test samples to the testing laboratory.
 - d. The Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements

- e. Failure of the Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered; neither does it obligate the Contracting Officer or Government to grant final acceptance of the Work.
 - 2. Compressive Strength Test:
 - a. Test Procedure:
 - 1) A test sample will be obtained from the first placement of the day and for every 3 cubic yards of grout placed each day.
 - 2) The grout will be tested in accordance with the requirements of ASTM C109 modified in accordance with the requirements of ASTM C1107.
 - b. Acceptance Criteria:
 - 1) Grout meeting the requirements specified in Subparagraph 1.05 will be acceptable.
 - 3. Inspections:
 - a. All grout placements will be visually inspected to verify if proper placement procedures are being followed.
- B. Non-Conforming Work
- 1. Remove under-strength grout and replace the removed grout with grout meeting the specified requirements.

END OF SECTION

**SECTION 04 20 00
UNIT MASONRY****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Concrete block.
- B. Concrete building brick.
- C. Reinforcement and anchorage.
- D. Accessories.

1.02 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- B. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
- C. ASTM A951/A951M - Standard Specification for Steel Wire for Masonry Joint Reinforcement.
- D. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- E. ASTM C90 - Standard Specification for Dry-Cast Loadbearing Concrete Masonry Units.
- F. ASTM C91/C91M - Standard Specification for Masonry Cement.
- G. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
- H. ASTM C150/C150M - Standard Specification for Portland Cement.
- I. ASTM C270 - Standard Specification for Mortar for Unit Masonry.
- J. ASTM C476 - Standard Specification for Grout for Masonry.
- K. ASTM C780 - Standard Test Methods for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
- L. ASTM C1714/C1714M - Standard Specification for Preblended Dry Mortar Mix for Unit Masonry.
- M. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures.
- N. UL (FRD) - Fire Resistance Directory.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by all relevant installers.

1.04 SUBMITTALS

- A. Product Data: Provide data for masonry units, fabricated wire reinforcement, and masonry accessories.
- B. Shop Drawings: Indicate reinforcement bar sizes, spacings, quantities, bending and cutting schedules, supporting and spacing devices, and accessories.
- C. Shop Drawings: Indicate pertinent dimensions, materials, anchorage, size and type of fasteners, and accessories for brickwork support system.
- D. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

- A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.
- B. Fire Rated Assemblies: Conform with applicable code for all requirements for fire rated masonry construction.

- C. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section with minimum three years of documented experience.
- D. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

- A. Concrete Block: Comply with referenced standards and as follows:
 - 1. Size: Standard units with nominal face dimensions of 16 by 8 inches and nominal depths as indicated on drawings for specific locations.
 - 2. Special Shapes: Provide non-standard blocks configured for corners, lintels, control joint edges, sills, bond beams, and other detailed conditions.
 - a. Provide bullnose units for visible outside corners.
 - 3. Load-Bearing Units and Non-Load Bearing: ASTM C90, normal weight.
 - a. Both hollow and solid block, as indicated.
 - b. Exposed Faces: Manufacturer's standard color and texture except where indicated.
 - 4. Fire Rated CMU: Where fire-resistance rated concrete masonry walls are indicated, use the appropriate aggregates in the manufacturing of the CMU to provide the required fire rating for the wall thickness indicated.

2.02 MORTAR AND GROUT MATERIALS

- A. Masonry Cement: ASTM C91/C91M, Type S.
- B. Portland Cement: ASTM C150/C150M, Type I; color as required to produce approved color sample.
- C. Mortar Aggregate: ASTM C144.
- D. Water: Clean and potable.
- E. Accelerating Admixture: Nonchloride type for use in cold weather.
- F. Packaged Dry Material for Mortar for Unit Masonry: Premixed Portland cement, hydrated lime, and sand; complying with ASTM C1714/C1714M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
 - 1. Type: Type S.
 - 2. Color: Standard gray.

2.03 REINFORCEMENT AND ANCHORAGE

- A. Manufacturers for Joint Reinforcement and Anchorage Products:
 - 1. Blok-Lok Limited: www.blok-lok.com/#sle.
 - 2. Hohmann & Barnard, Inc: www.h-b.com/#sle.
 - 3. Or Approved Equal.
- B. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi), deformed billet bars; uncoated.
- C. Joint Reinforcement: Use ladder type joint reinforcement where vertical reinforcement is involved and truss type elsewhere, unless otherwise indicated.
- D. Single Wythe Joint Reinforcement: ASTM A951/A951M.
 - 1. Material: ASTM A1064/A1064M steel wire, hot dip galvanized after fabrication to ASTM A153/A153M Class B.
 - 2. Size: 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not less than 5/8 inch of mortar coverage on each exposure.
- E. Flexible Anchors: 2-piece anchors that permit differential movement between masonry and building frame, sized to provide not less than 5/8 inch of mortar coverage from masonry face.

1. Steel frame: Crimped wire anchors for welding to frame, 0.25 inch thick, with trapezoidal wire ties 0.1875 inch thick, hot dip galvanized to ASTM A 153/A 153M, Class B.

2.04 ACCESSORIES

- A. Preformed Control Joints: Rubber material. Provide with corner and tee accessories, fused joints.
- B. Joint Filler: Closed cell polyvinyl chloride; oversized 50 percent to joint width; self expanding; in maximum lengths available.
- C. Nailing Strips: Softwood lumber, preservative treated for moisture resistance, dovetail shape, sized to masonry joints.
- D. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.05 LINTELS

- A. Reinforced Unit Masonry Lintels: Field built with units as specified above under "Concrete Masonry Units."

2.06 MORTAR AND GROUT MIXING

- A. Mortar for Unit Masonry: ASTM C270, using the Proportion Specification.
 1. Masonry below grade and in contact with earth: Type M.
 2. Exterior, loadbearing masonry: Type S.
 3. Exterior, non-loadbearing masonry: Type N.
 4. Interior, loadbearing masonry: Type S.
 5. Interior, non-loadbearing masonry: Type N.
- B. Grout: ASTM C476; consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches.
- C. Admixtures: Add to mixture at manufacturer's recommended rate and in accordance with manufacturer's instructions; mix uniformly.
- D. Mixing: Use mechanical batch mixer and comply with referenced standards.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive masonry.
- B. Verify that related items provided under other sections are properly sized and located.
- C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 PREPARATION

- A. Direct and coordinate placement of metal anchors supplied for installation under other sections.
- B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.
- C. Clean reinforcement of loose rust.

3.03 COLD AND HOT WEATHER REQUIREMENTS

- A. Maintain materials and surrounding air temperature to minimum 40 degrees F prior to, during, and 48 hours after completion of masonry work.
- B. Maintain materials and surrounding air temperature to maximum 90 degrees F prior to, during, and 48 hours after completion of masonry work.

3.04 COURSING

- A. Establish lines, levels, and coursing indicated. Protect from displacement.
- B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.

- C. Concrete Masonry Units:
 - 1. Bond: Running.
 - 2. Coursing: One unit and one mortar joint to equal 8 inches.
 - 3. Mortar Joints: Concave.

3.05 PLACING AND BONDING

- A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
- B. Lay hollow masonry units with face shell bedding on head and bed joints.
- C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
- D. Remove excess mortar and mortar smears as work progresses.
- E. Remove excess mortar with water repellent admixture promptly. Do not use acids, sandblasting or high pressure cleaning methods.
- F. Interlock intersections and external corners.
- G. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- H. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
- I. Cut mortar joints flush where wall tie is scheduled.
- J. Isolate masonry partitions from vertical structural framing members with a control joint as indicated.
- K. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.

3.06 REINFORCEMENT AND ANCHORAGE - GENERAL

- A. Joint Reinforcement: Unless otherwise indicated on drawings or specified under specific wall type, install horizontal joint reinforcement 16 inches on center.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.
- C. Place continuous joint reinforcement in first and second joint below top of walls.
- D. Embed longitudinal wires of joint reinforcement in mortar joint with at least 5/8 inch mortar cover on each side.
- E. Lap joint reinforcement ends minimum 6 inches.
- F. Reinforce stack bonded unit joint corners and intersections with strap anchors 16 inches on center.
- G. Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 36 inches horizontally and 24 inches vertically.
- H. Embed ties and anchors in mortar joint and extend into masonry unit a minimum of 1-1/2 inches with at least 5/8 inch mortar cover to the outside face of the anchor.
- I. Reinforced Hollow Unit Masonry: Keep vertical cores to be grouted clear of mortar, including bed area of first course.
 - 1. Bond Beams, Masonry Lintels, and Similar Conditions: At bond beams or other locations for horizontally reinforced masonry, provide special masonry units or saw to accommodate reinforcement.

3.07 LINTELS

- A. Where steel lintels are indicated, build in as masonry is being erected and anchor as indicated.

- B. Install reinforced unit masonry lintels over openings where steel or precast concrete lintels are not scheduled.
 - 1. Openings to 42 inches: Place two, No. 4 reinforcing bars 1 inch from bottom web.
 - 2. Openings from 42 inches to 78 inches: Place two, No. 5 reinforcing bars 1 inch from bottom web.
 - 3. Openings over 78 inches: Reinforce openings as detailed.
 - 4. Do not splice reinforcing bars.
 - 5. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
 - 6. Place and consolidate grout fill without displacing reinforcing.
 - 7. Allow masonry lintels to attain specified strength before removing temporary supports.
- C. Maintain minimum 8 inch bearing on each side of opening.

3.08 GROUTED COMPONENTS

- A. Reinforce bond beams with 2, No. 4 bars, 1 inch from bottom web unless otherwise indicated on the drawings.
- B. Lap splices minimum 24 bar diameters.
- C. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
- D. Place and consolidate grout fill without displacing reinforcing.
- E. At bearing locations, fill masonry cores with grout for a minimum 12 inches either side of opening.

3.09 CONTROL AND EXPANSION JOINTS

- A. Do not continue horizontal joint reinforcement or reinforcement bars through control or expansion joints.
- B. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.
- C. Size control joints as indicated on drawings; if not indicated, 1/2 inch wide and deep.

3.10 BUILT-IN WORK

- A. As work progresses, install built-in door frames, glazed frames, anchor bolts, and plates and other items to be built into the work and furnished under other sections.
- B. Install built-in items plumb, level, and true to line.
- C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout. Coordinate with grout requirements in applicable Division 08 door and frame Sections.
 - 1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.
- D. Do not build into masonry construction organic materials that are subject to deterioration.

3.11 TOLERANCES

- A. Maximum Variation from Alignment of Columns: 1/4 inch.
- B. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
- C. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.
- D. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
- E. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.
- F. Maximum Variation of Mortar Joint Thickness: Head joint, minus 1/4 inch, plus 3/8 inch.
- G. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.12 CUTTING AND FITTING

- A. Cut and fit for chases, pipes, conduit, sleeves, and other penetrations. Coordinate with other sections of work to provide correct size, shape, and location.
- B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.13 FIELD QUALITY CONTROL

- A. An independent testing agency employed by Owner will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.
- B. Mortar Tests: Test each type of mortar in accordance with ASTM C780, testing with same frequency as masonry samples.

3.14 CLEANING

- A. Remove excess mortar and mortar droppings.
- B. Replace defective mortar. Match adjacent work.
- C. Clean soiled surfaces with cleaning solution.
- D. Use non-metallic tools in cleaning operations.

3.15 PROTECTION

- A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION

**SECTION 05 12 00
STRUCTURAL STEEL**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This Section covers the design, fabrication, and installation of structural metal framing.

1.02 RELATED SECTIONS

- A. Section 03 60 00: Grout.
- B. Section 05 31 00: Metal Deck.
- C. Section 05 44 00: Light Gauge Roof Truss.

1.03 REFERENCES

- A. American Institute of Steel Construction (AISC):
1. AISC 360; Specification for Structural Steel Buildings.
 2. AISC 303; Code of Standard Practice for Steel Buildings and Bridges.
 3. Specification for Structural Joints Using High-Strength Bolts.
- B. American National Standards Institute (ANSI):
1. ANSI B18.22.1, Plain Washers.
- C. ASTM International (ASTM):
1. ASTM A36, Standard Specification for Carbon Structural Steel.
 2. ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 3. ASTM A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 4. ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 5. ASTM A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 6. ASTM A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 7. ASTM A563, Standard Specification for Carbon and Alloy Steel Nuts.
 8. ASTM A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
 9. ASTM A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 10. ASTM A992, Standard Specifications for Structural Steel Shapes.
 11. ASTM E164, Standard Practice for Contact Ultrasonic Testing of Weldments.
 12. ASTM E709, Standard Guide for Magnetic Particle Testing.
 13. ASTM F436, Standard Specification for Hardened Steel Washers.
 14. ASTM F959, Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
 15. ASTM F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength.
 16. ASTM F1852, Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

17. ASTM F2329, Standard Specification for Zinc Coating, Hot Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

- D. American Welding Society (AWS):
 1. AWS D1.1 Structural Welding Code - Steel.
- E. SSPC ;The Society for Protective Coatings:
 1. SSPC Painting Manual.

1.04 SUBMITTALS

- A. Structural Steel Shop Drawings:
 1. Submit shop drawings identifying the details as indicated on Drawings, indicating completely the location in the project, the size and weights of the members, the methods of joining various components, the quantity, finish, the location and type of anchors and necessary measurements.
 2. Provide easy-to-read markings on shop and erection drawings for shop assemblies which require markings for erection identification.
 3. Note on shop drawings variations in tolerances or clearances between various products.
 4. Use standard welding symbols of the AWS on shop drawings; show size, length, and type of each weld.
 5. Provide shop drawings prepared under the supervision of and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania experienced in structural engineering.
- B. Working Drawings:
 1. Furnish setting diagrams, templates, and directions for the installation of structural framing anchor bolts, bearing plates, and other embedded items.
- C. Project Standards:
 1. Submit standards for typical beam, girder, column splices, and moment connection details prior to submitting detail drawings; standards shall be prepared under the supervision of and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania.
- D. Connection Calculations:
 1. Design all connections in accordance with AISC Specifications for Structural Steel Buildings Using Allowable Strength Design.
 2. Submit calculations prepared and sealed by a Professional Engineer, licensed in the Commonwealth of Pennsylvania and experienced in structural engineering.
 3. Use type of shop and field connections shown or, in absence of such indication, use the most appropriate type. Connections shall safely withstand the combined effects of shears, direct forces, moments, and torques at applicable design stresses.
 4. Connection details shown on the drawings are illustrative only.
 5. Design and detail connections so interference does not occur with architectural clearance lines and finishes.
 6. One-sided or other eccentric connections are not permitted unless detailed on the Contract Drawings.
- E. Product Data:
 1. Submit data for approval related to the following:
 - a. For items defined in Paragraph 2.01B this specification.
 - b. Welding electrodes.
 - c. Headed type studs.
 - d. Paint primer.

F. Welding Certifications:

1. Prior to commencing work requiring welding, submit the procedure which will be used for prequalifying welders and welding procedures. For all procedures other than those set forth in AWS D1.1, submit a copy of procedure qualification test records.
2. Submit certified copy of qualification test record showing each welder, welding operator, and tacker who will be employed in the work has satisfactorily passed AWS qualification tests for welding procedures.
3. Submit certified copy of reports for all analyses and tests required by referenced ASTM Specifications, including test reports for filler metals for welding, and mechanical tests for high-strength threaded fasteners.

G. Test Results:

1. Submit reports signed by the manufacturer certifying their products comply with requirements specified.
2. Submit test reports certifying material conforms to ASTM specification.
3. Submit guarantee showing all steel used for this project is American-made.
4. Submit testing reports to the Contracting Officer.

H. Qualification Statement:

1. Submit qualification statement denoting the requirements of this specification are met by the following:
 - a. Structural steel fabricator qualifications
 - b. Structural steel erector qualifications
 - c. Professional Land Surveyor
 - d. Hot-Dip Galvanizing Company.

I. An Independent Testing and Inspection Agency (Approved Agency) shall submit inspection and testing reports required by this Section.

1.05 QUALITY CONTROL

A. Qualifications:

1. Fabricator: Company experienced in fabricating structural steel similar to that indicated for the project who has a successful in-service performance for a minimum of 5 continuous years and sufficient production capacity.
 - a. Fabricator must participate in the AISC Quality Certification Program and be designated an AISC Certified Building Fabricator (BU) at time of bid.
 - b. Fabricator shall have sufficient production capacity to produce and deliver the materials on time to meet the approved construction schedule for this Contract.
2. Erector: Company experienced in erecting structural steel work similar to that indicated for the project who has a successful in-service performance with a minimum of 5 continuous years of experience.
 - a. Erector must participate in the AISC Quality Certification Program and be designated an AISC Certified Erector (CSE) at time of bid.
3. Welder, Tacker, and Welding Operator Qualifications: Use welders, tackers, and welding operators who have been previously qualified by tests as prescribed in the Structural Welding Code, AWS D1.1 of the American Welding Society to perform type of work required.
4. Land Surveyor: A surveyor licensed in the Commonwealth of Pennsylvania who is qualified to determine and verify the top of steel elevations and the edge of slab locations for each elevated framed level and to verify the structure is square, plumb, and level in accordance with AISC tolerances.
5. Hot-Dip Galvanizing Plant Qualification:
 - a. Company shall be a member of the American Galvanizers Association (AGA).

- b. Submit letter denoting plant location proposed for the defined work and number of years of experience performing galvanizing work similar to work denoted in this Contract.
- B. Comply with applicable provisions listed in those references stated in Paragraph 1.03 of this specification unless otherwise indicated.
- C. Structural Tests and Special Inspection
 - 1. Materials and fabrication procedures are subject to inspection and tests in mill, shop, and field by an Independent Testing and Inspection Agency (Approved Agency).
 - 2. Such inspections and tests will not relieve the Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements.
 - a. Promptly remove and replace materials or fabricated components that do not comply.
 - b. Requirements for code-related Special Inspections are defined in Division 1 Specification Section.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site at such times and intervals to ensure continuity of installation and uninterrupted progress of work.
- B. Store steel on platforms, skids, blocking or other supports to prevent dirt and debris contact. Protect from exposure to conditions that produce rust.
- C. Handle steel so no parts are bent, broken, or otherwise damaged and avoid damage to other material and work. Store beams with webs vertical. Exercise care to avoid scraping and over stressing the steelwork.
- D. Mark weight on all members. Match-mark all shop pre-fitted members.
- E. Ship small parts, such as bolts, nuts, washers, pins, fillers, and small connecting plates and anchors in boxes, crates, or barrels. Pack separately each length and diameter of bolt and each size of nut and washer. Plainly mark an itemized list and description of the contents on the outside of each container.
- F. Replace pieces bent or damaged unless repairs are authorized by the Contracting Officer.

1.07 JOB CONDITIONS

- A. Provide anchor rods and other anchorage items to be embedded in or attached to concrete, masonry, or other materials in ample time to not delay work.
 - 1. Furnish setting drawings, templates, and installation directions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Steel
 - 1. Structural Steel: ASTM A36, ASTM A572 Grade 50, ASTM A992; as noted on drawings.
 - 2. Structural Steel Rectangular (Square) HSS Tubing: ASTM A500, Grade C
 - 3. Structural Steel Round HSS: ASTM A500, Grade C.
 - 4. Structural Steel Pipe: ASTM A53, Grade B.
- B. Fasteners

1. High-Strength Bolted Connections:
 - a. High Strength Bolts: ASTM A325.
 - b. Carbon and Alloy Steel Nuts: ASTM A563.
 - c. Hardened Steel Washers: ASTM F436, Type 1.
 - d. Direct Tension Indicators (for use in slip-critical and pre-tensioned connections): ASTM F959, Type 325.
 - e. Twist-Off-Type Tension Control Bolt Assemblies: ASTM F1852.
 2. Fastener Assemblies:
 - a. Galvanized high-strength bolts and nuts are considered to be a fastener assembly; both elements must be galvanized by the same process.
 - b. Supply nuts that are lubricated.
 - c. The bolt, lubricated nut, and washer assembly shall be tested prior to shipment.
 - d. Galvanize materials in accordance with the requirements specified in ASTM F2329.
 3. Anchor Rods:
 - a. Rods: ASTM F1554, Grade 36, 55, 105 as noted on drawings.
 - b. Nuts: ASTM A563.
 - c. Washers: ASTM F436.
 4. Bolt Lubricant: Molybdenum disulfide base lubricant.
 5. Expansion Anchors and Adhesive Anchors:
 - a. As specified in Section 033000.
- C. Welding Electrodes:
1. AWS D1.1, E70XX.
 2. Use low-hydrogen electrodes for field welding.
- D. Paints and Coatings:
1. Primer Coat:
 - a. Primer shall be compatible with selected finish coat.
 - b. Provide a two-component, fast-curing, low volatile organic compound (VOC), metallic zinc-rich epoxy primer complying with the requirements specified in SSPC Paint 20 to steel members that do not receive intumescent finish paint coating.
 2. Finish Coat: See Section 09900.
 3. Below Grade Coating: Coal tar epoxy.
 4. Galvanizing: Hot-dip galvanize steel members and fabrications specified to be galvanized in accordance with ASTM A123.
 - a. Coating Weight: Conform with Paragraph 6.1 of ASTM A123.
 - b. Repair areas damaged by welding, flame cutting or during handling, transport and erection by an approved method in accordance with ASTM A780.
- E. Non-Shrink, Non-Metallic Grout: As specified in Section 036000.

2.02 FABRICATION

- A. Fabricate structural steel in accordance with the Contract Drawings and the AISC standards referenced in Paragraph 1.03A.
- B. Perform shearing, flame cutting, and chipping carefully and accurately, so as not to induce residual stress in the metal being cut.
1. Flame-cut the edges of members subjected to dynamic loading either by using a mechanically guided torch or by hand and remove all nicks.
 - a. Fabricate the radii of re-entrant gas-cut fillets as large as practicable, but in no case less than $\frac{3}{4}$ inch.
 - b. Perform flame cuttings so that the metal is not carrying stress.
 - c. Finish the exposed edges of members that were flame-cut by hand by grinding.
 2. Add additional reinforcing as required where members are cut or coped to meet framing conditions.

- C. Bolt Holes:
 - 1. Punch, drill, subpunch, subdrill, and ream holes for bolts as required in accordance with the requirements specified in the AISC Specifications referenced in Paragraph 1.03A.
- D. Holes for Other Work:
 - 1. Provide holes required for securing other work to structural steel framing and for passage of other work through members as shown on final approved shop drawings.
 - a. Ream, drill, or punch holes perpendicular to metal surface.
 - b. Do not flame-cut holes or enlarge by burning.
 - 2. Do not make additional openings in members not shown on the final approved shop drawings unless approval to do so is received from the Contracting Officer.
- E. Mill the ends of columns and other members that will transmit loads in bearing.
- F. Except where welded connections are shown, use ASTM A325 bolts for shop connections.
 - 1. Install and tighten high-strength bolts in accordance with the requirements of the RCSC Specification for Structural Joints Using High-Strength Bolts.
 - 2. Arrange the bolts as indicated on the Contract Drawings; or if not indicated, arrange the bolts so heads show in areas exposed to view.
 - 3. Clearly indicate the bolt arrangements on shop drawing submittals.
- G. Welding:
 - 1. Perform all welding in accordance with AWS D1.1 except as modified herein.
 - 2. Use a welding procedure and sequence of welding that prevents needless distortion and minimize stresses.
 - a. If it is necessary to straighten transverse warpage of flanges, use controlled heating along outside face.
 - b. Allow for expected weld shrinkage when laying out and assembling members in the shop.
 - c. Trim members to size only when most or all of welding has been completed.
 - 3. Weld tabs for temporary bracing and safety cabling at points concealed from view in the completed structure.
- H. Properly mark and match-mark materials to facilitate handling and field assembly.
 - 1. Mark each member with its weight.
 - 2. Match-mark all shop pre-fitted members.

2.03 FINISHES

- A. Cleaning:
 - 1. After fabrication, clean heavy deposits of oil and grease from unpainted steel surfaces in accordance with AISC's Code of Standard Practice.
- B. Shop Priming:
 - 1. Surface Preparation:
 - a. Clean the surfaces in accordance with the requirements of SSPC-SP 3 Power Tool Cleaning following the SSPC Painting Manual.
 - 2. Primer:
 - a. Immediately after surface preparation, apply the fabricator's standard rust-inhibiting primer according to the manufacturer's instructions at a rate as recommended in the SSPC Painting Manual to provide a dry film thickness of not less than 1.5 mils.
 - b. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 - c. For members to receive intumescent paint, apply a primer compatible with the finish coat.

- C. Finish Coat:
 - 1. Apply finish coats of paint to structural steel in accordance with the requirements of Section 09 90 00.
- D. Below Grade Coating:
 - 1. Where structural steel is placed below grade, apply a coal tar epoxy coating to a total thickness of 20 mils.
- E. Galvanizing:
 - 1. For structural steel specified to be galvanized, hot dip galvanize the steel members and fabrications in accordance with ASTM A123 and to the thicknesses specified therein.
 - 2. Repair galvanized areas damaged by welding and flame cutting and during handling, transport, and erection by using an approved repair method in accordance with ASTM A780.
- F. Do not paint the following surfaces of structural steel members:
 - 1. Connection plates and members where slip-critical connections are required.
 - 2. Surfaces in contact with fireproofing.
 - 3. Surfaces to be encased in concrete, except for the initial two (2) inches of the length embedded.
 - 4. Top flanges of beams to which metal decking or shear connectors are to be attached.
 - 5. Surfaces that are within ½ inch of the toe of a weld prior to welding.

2.04 SOURCE QUALITY CONTROL

- A. Materials and fabrication procedures are subject to inspection and tests by an Independent Testing and Inspection Agency (Approved Agency) in the mill and shop.
 - 1. Provide the Approved Agency with access to the places where structural steel work is being fabricated or produced so the required inspections and testing can be performed before the work is shipped.
- B. Shop-Bolted Connections:
 - 1. The Approved Agency will inspect and test the shop-bolted structural steel connections in accordance with the AISC specifications listed in Paragraph 1.03A.
 - a. Verify proper fastening components were used and the connected elements were fabricated properly.
 - b. For slip-critical and pretension connections, test 2 bolts per connection.
 - 2. Acceptance Criteria:
 - a. Verify proper fastening component used.
 - b. Verify proper fabrication of connected elements.
- C. Shop Welding:
 - 1. The Approved Agency will verify all welders and welding materials being supplied under this Contract are properly certified and will conduct the inspections and tests specified.
 - a. Inspect and test shop welds made during fabrication of structural steel assemblies by performing a visual inspection of the full length of all welds and inspecting and testing shop-welded connections in accordance with the requirements of ASTM E164 and the following:
 - 1) Ultrasonically inspect and test the entire length of all full penetration welds in accordance with the requirements of ASTM E164.
 - 2) Inspect the entire length of fillet welds in accordance with the requirements for the Magnetic Particle Method specified in ASTM E709 and the following:
 - a) For gusset plates welded to steel members, test 50 percent of fillet weld locations.
 - b) For all other fillet weld locations, test a minimum of 5 percent of the welds.

- b. Record both the type and location of all defects found in the work, and record the work required and the work performed to correct deficiencies.
- 2. Acceptance Criteria:
 - a. Verify weld materials, locations, and types agree with Construction Documents.
 - b. Verify welds comply with AWS D1.1.
- D. Submit mill test reports certifying the material provided conforms to the appropriate ASTM specification.
- E. Promptly remove and replace materials or fabricated components that do not comply with specified requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Before proceeding to erect the structural steel, verify the elevations of concrete and masonry bearing surfaces and locations of anchorages are in compliance with the Contract Documents and ready to receive the work of this Section.
- B. Ensure anchor rods and other embedded items, that vary in location from the dimensions shown on the Contract Drawings, are positioned within the tolerances listed in the AISC Code of Standard Practice for Steel Buildings and Bridges.
- C. Do not proceed with erection until unsatisfactory conditions have been corrected.
 - 1. Immediately report errors in the structural steel, whether resulting from shop fabrication or deformation resulting from handling or transportation, which will prevent the proper erection and fitting of parts.

3.02 ERECTION

- A. 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.
 - 1. Leave temporary bracing in place as long as required for safety.
- B. Erect steel structures plumb in the location and at the elevations shown on the Contract Drawings and in accordance with the match marks, pertinent regulations, and the AISC standards referenced in Paragraph 1.03A.
 - 1. Align column bases and bearing plates for beams and similar structural members using steel wedges or shims.
 - 2. Do not field cut or alter structural members without the approval of the Contracting Officer.
 - 3. Allow concrete foundations to cure for a minimum of 14 days before tightening anchor rod hardware.
 - a. Do not tighten anchor rod hardware using impact torque wrenches.
 - 4. Apply a coal tar epoxy coating to steel below grade.
- C. Bolted Connections:
 - 1. For connections using high-strength steel bolts, conform to requirements of the AISC Specifications referenced in Paragraph 1.03A.
 - a. Assemble high strength bolted parts so they fit solidly together when assembled.
 - 1) Remove scale, dirt, and other defects liable to prevent proper seating when joint surfaces are assembled, including joint surfaces adjacent to washers.
 - 2) Do not use gaskets or any other interposed compressible materials.

- 3) Only use drift pins for bringing members into position, not to enlarge or distort holes.
 2. Ensure holes are not enlarged and the metal in the vicinity of the holes is not disturbed by drifting during assembly.
 - a. Enlarge holes to admit bolts for connections only if approved by the Contracting Officer.
 - 1) Make the enlargement by reaming and not by burning.
 - 2) Avoid hand reaming.
 3. As erection progresses, install sufficient bolts in the work to resist dead loads, wind loads, and erection loads.
 - a. Arrange and insert the bolts so bolt heads show in areas exposed to view.
 - b. Perform permanent bolting when sufficient alignment has been completed to ensure as much of the structure as possible will be supported by such fastening work.
 4. For bearing-type (snug-tightened) connections, tighten the ASTM A325 bolts to a snug tight condition by either applying a few impacts from an impact wrench or the full effort of an ironworker using an ordinary spud wrench, so all plies of the connected material have been brought into snug contact.
 5. For slip-critical and pretension connections, tighten the ASTM A325 bolts, nuts, and direct tension indicators or twist-off-type tension control bolt in accordance with the AISC specifications listed in Paragraph 1.03A.
 - a. Clean oil, paint, or lacquer from the contact surfaces of slip-critical joints.
 - b. Place direct tension indicators under either the bolt head or the hardened washer.
 - 1) If direct tension indicators are placed under the turned element, place a hardened round steel washer between the direct tension indicator and the turned element.
 - c. To ensure proper tensioning of these connections is achieved, have a representative from the direct tension indicator supplier on site during their initial tightening to witness and approve of the degree of tightening.
- D. Field Welding:
1. Provide only where approved by the Contracting Officer or as indicated in the approved shop drawings.
 - a. Securely tighten erection bolts used in welded construction and leave them in place.
 - b. Field welding rigid frame flange connection plates on columns may only be performed if required for ease of erection and must be clearly indicated on the approved shop drawings and approved by the Contracting Officer.
- E. After the supported members have been aligned, properly positioned, and the anchor nuts have been tightened, dry pack the entire area under bearing plates with non-shrink non-metallic grout.
1. Do not place concrete on steel structure until the grout is in place and anchor bolts have been tightened.
- F. Prior to installing metal decking, clean all heavy rust, mill scale, dirt, or other material from the unpainted top flanges of supporting beams.

3.03 FIELD QUALITY CONTROL

- A. An Independent Testing and Inspection Agency (Approved Agency) shall be engaged to inspect high strength bolted connections and welded connections, to perform the specified tests, and interpret the test results; to confirm that the structure is square, plumb, and level in accordance with AISC tolerances and to prepare and submit test reports for this work.
- B. Field-Bolted Connections:
1. The Approved Agency will inspect and test the field-bolted structural steel connections in accordance with the AISC specifications listed in Paragraph 1.03A and as specified.

- a. Verify proper fastening components were used and the connected elements were fabricated properly.
 - b. Slip-critical and pretension connections, test 2 bolts per connection.
 - 2. Acceptance Criteria:
 - a. Verify connections comply with the requirements specified in AISC and RCSC specifications.
- C. Field Welding:
 - 1. The Approved Agency will verify all welders and welding materials in the field are properly certified and will conduct the inspections and tests specified.
 - a. Inspect and test field welds, in accordance with the requirements of AWS D1.1, made during erection of structural steel assemblies by performing a visual inspection of the full length of all welds and the following:
 - 1) Ultrasonically inspect and test the entire length of full penetration welds in accordance with the requirements of ASTM E164:
 - 2) Inspect the entire length of fillet welds in accordance with the requirements for the Magnetic Particle Method specified in ASTM E709 and the following:
 - a) For beam connection plates (angles) welded to plates embedded in concrete, test all welds.
 - b) For diagonal bracing members welded to gusset plates, test 50 percent of fillet weld locations.
 - c) For gusset plates welded to steel members, test 50 percent of fillet weld locations.
 - d) For all other fillet weld locations, test a minimum of 20 percent of the welds.
 - b. Record both the type and location of all defects found in the work, and record the work required and the work performed to correct deficiencies.
 - 2. Acceptance Criteria:
 - a. Verify welds comply with the requirements specified in AWS and ASTM specifications will be acceptable.
 - b. Verify welders and welding materials are properly certified.
- D. Verification of Conditions
 - 1. Have the Professional Land Surveyor survey each elevated framed level to determine the top of steel elevations and verify that the structure is square, plumb, and level in accordance with AISC tolerances.
 - 2. Verify only erectors qualified as specified herein erect the structural steel.

3.04 REPAIR/RESTORATION

- A. Remove and replace work that does not comply with specified requirements.
 - 1. Correct deficiencies in structural steel work that inspections and test reports have indicated to be not in compliance with requirements.
 - 2. Additional tests performed by the Approved Agency to reconfirm any noncompliant original work and verify compliance of corrected work will be performed at no additional cost to the Government.
- B. Immediately after erection, clean field welds, bolted connections, and areas where shop paint is abraded; prime them with paint of the same quality as that used for the shop coat in accordance with the requirements specified in Section 09900.
 - 1. Repair galvanized areas damaged by welding and flame cutting and during handling, transport, and erection by using an approved repair method in accordance with ASTM A780.
- C. Apply touch-up paint to exposed areas using material as specified in Section 09900.

- D. Repair galvanized areas damaged by welding and flame cutting and during handling, transport, and erection by using an approved repair method in accordance with ASTM A780.

3.05 NON-CONFORMING WORK

- A. Non-Conforming Work
 - 1. Promptly remove and replace Work that does not comply with specified requirements.
 - a. Correct deficiencies in the Work that inspections and test reports have indicated to be not in compliance with requirements.
 - 2. Record the work required and the work performed to correct deficiencies in field welding.
 - 3. Depending on the amount of non-conforming work encountered, the amount of testing required may be modified.

END OF SECTION

**SECTION 05 21 00
STEEL JOIST FRAMING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies fabricating, furnishing, and installing steel joists at locations indicated on the Drawings.

1.02 RELATED WORK

- A. Section 05 12 00: Structural Steel Framing.
- B. Section 09 90 00: Painting and Coating.

1.03 REFERENCES

- A. Steel Joist Institute (SJI):
 - 1. Standard Specifications for Open Web Steel Joists, K-Series (Latest Edition).
 - 2. Code of Standard Practice for Steel Joists and Joist Girders (Latest Edition).
- B. American Welding Society (AWS):
 - 1. AWS D1.1: Structural Welding Code - Steel.
- C. Occupational Safety and Health Administration (OSHA) Code of Federal Regulations (CFR):
 - 1. 29 CFR 1926: Safety and Health Regulations for Construction.
- D. SSPC; The Society for Protective Coatings:
 - 1. SSPC-SP 1: Solvent Cleaning.
 - 2. SSPC-Paint 15: Steel Joist Shop Primer/Metal Building Primer, Type I, Red Oxide Paint.

1.04 SUBMITTALS

- A. Steel Joist Fabricator certification.
- B. Certificate of Compliance at completion of fabrication stating work was performed in accordance with Contract Drawings and SJI standard specifications.
- C. Detailed drawings showing layout of joist units, special connections, jointing, and accessories. Include the mark, number, type, location, and spacing of joists and bridging. Include templates or location drawings for installation of anchor bolts.
- D. Installation instructions for each type of joist and its accessories.
- E. Design calculations with a cover letter bearing the seal and signature of a licensed professional engineer for all non-standard SJI joists designated on the Contract

Drawings. Joists shall be designed for the tabulated loads and deflection criteria noted.

F. Welder's Certificates:

1. Submit certificates certifying welders employed on the work, verifying AWS qualifications within the previous 12 months.

1.05 QUALITY ASSURANCE

A. Provide joists fabricated in compliance with the following, and as herein specified.

1. SJI Standard Specifications and Load Tables for steel joists.

B. The steel joist fabricator shall provide evidence of successful fabrication of steel joist systems of similar size and complexity for a continuous period of at least five (5) years or immediately prior to the bid date. Fabricator must be certified by SJI to manufacture joists complying with SJI standards.

C. The steel joist erector shall provide evidence of successful erection of steel joist systems of similar size and complexity for a continuous period of five (5) years immediately prior to the bid date.

D. Qualification of Welding Work:

1. Qualify welding processes and welding operators in accordance with AWS D1.1.
2. Joists welded in place are subject to inspection and testing.
3. Shop welds made on joists are subject to inspection and testing.

E. Professional Engineer Qualifications:

1. A professional engineer, licensed in the Commonwealth of Pennsylvania, experienced in engineering services related to steel joist systems shall prepare design calculations, shop drawings, and other structural data necessary to comply with project requirement.

F. An Independent Testing and Inspection Agency (Approved Agency) hired by the Government will perform testing and inspections as defined in this Specification.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle steel joists as recommended by SJI. Handle and store joists in a manner to avoid deforming members, avoid excessive stress, and maintain shop coat of paint intact without rusting.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide steel joists manufactured by one of the following:

1. Vulcraft, Division of Nucor Corp.
2. New Millennium Building Systems.

3. Canam Steel Corporation.
4. Or approved equal.

2.02 MATERIALS

- A. Steel: Comply with SJI; use steel having a yield strength of 50,000 psi.
- B. Accessories:
 1. Manufacturer's standard accessories complying with SJI.
 2. Furnish anchor bolts and other devices to be built into concrete and masonry construction for attaching the steel joists.
 - a. Provide anchors in accordance with the requirements of Section 05 12 00.
 - b. Furnish templates for the accurate location of anchors in such other work.
- C. Welding Electrodes: Use electrodes conforming to the current AWS Specifications adopted by SJI.

2.03 FABRICATION

- A. General: Fabricate steel joists in accordance with SJI Specifications.
- B. Holes in Chord Members: Provide holes in chord members only where shown for securing other work to the steel joists, deduct the area of holes from the area of the chord when calculating the strength of the member.
- C. Shop Splices: Joist chord splices shall be made by attaching the members to one another by arc or resistance welding or other accredited method.
 1. Acceptance criteria for welds shall follow SJI Standard Specification.
- D. Bridging:
 1. Provide horizontal and/or diagonal type bridging for joists complying with SJI.
 2. Provide bridging anchors for ends of all bridging lines terminating at walls or beams.
- E. End Anchorage: Provide end anchorages to secure joists to adjacent construction, complying with SJI, unless otherwise indicated.
- F. Header Units: Provide header units for K-series joists to support tail joists at openings in roof system not framed with steel shapes.
- G. Bearings: Provide special depth bearings for K-series joists where shown on drawings or where K-series joists are adjacent to LH- or DLH-series joists.
- H. Ceiling Extensions: Provide ceiling extensions in those areas where ceiling materials attach directly to joist bottom chord. Extend such ends no closer than one inch from wall surfaces.

2.04 FINISHES

- A. Steel Prime Paint:
 - 1. Apply with a minimum thickness of 1 mil.
 - 2. SSPC-Paint 15, Steel Joist Shop Primer/Metal Building Primer (red oxide).
- B. Shop Painting:
 - 1. Remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories and perform Solvent Cleaning (SSPC-SP 1) before applying shop paint.
 - 2. Apply one coat of primer paint to steel joists and accessories in accordance with manufacturer's recommended procedures at mil thickness specified.
 - 3. Do not prime surfaces that will be fireproofed.

2.05 SOURCE QUALITY CONTROL

- A. Provide access for the Approved Agency to place of steel joist fabrication so required inspections shall be accomplished.
- B. Joists shall be inspected by the manufacturer before shipment to verify compliance of materials and workmanship with the requirements of this specification and SJI Standard Specification.

PART 3 EXECUTION

3.01 ERECTION

- A. General: Place and secure steel joists in accordance with SJI, final shop drawings, OSHA 29 CFR 1926, and as herein specified.
 - 1. Prior to erection, the erector shall check elevations of concrete and masonry bearing surfaces and location of anchors before proceeding with erection. Report discrepancies to project representative.
 - 2. No modifications that affect the strength of the joist member shall be made without written approval of the Contracting Officer.
- B. Anchors:
 - 1. Furnish anchor bolts and other devices to be built into the concrete and masonry construction. Furnish templates for the accurate location of anchors in other work. Anchors per Specification Section 05 12 00.
- C. Placing Joists:
 - 1. Do not start placement of steel joists until supporting work is in place and secured.
 - 2. Place joists on supporting work, adjust, and align in accurate locations and spacing before permanently fastening.
 - 3. Provide temporary bridging, connections, and anchors to ensure lateral stability during construction.

4. Where concentrated load does not occur at panel point, place a steel reinforcement member from chord panel point to point of concentrated load.

D. Bridging:

1. Install bridging simultaneously with joist erection, before any construction loads are applied.
2. Anchor ends of bridging lines at top and bottom chords where terminating at walls or beams.
3. Rows of bridging shall not be less than shown in the SJI Standard Specification; see bridging table. In addition, a single line of bridging shall be provided at the first bottom chord panel point at each end of every joist.
4. Space bridging rows in span so spacing between bridging is uniform.

E. Fastening Joists:

1. Field weld ends of joists to supporting steel in accordance with SJI for the type of joist used. Coordinate welding sequence and procedure with the placing of joists.
2. Bolt joists to supporting steel at columns.

F. Touch-Up Painting:

1. After joist installation, paint all field bolt heads and nuts, and welded areas, abraded or rusty surfaces on joists and steel supporting members. Wire brush surfaces and clean with solvent before painting. Use the same type of paint as used for shop painting.

G. Finish Coat:

1. Apply finish coat of paint in accordance with the requirements of Section 09 90 00.

3.02 SITE QUALITY CONTROL

A. An Approved Agency shall be engaged to inspect placement and connections.

1. Written reports on all inspections shall be provided immediately after work is performed.

B. Inspections

1. The Approved Agency shall verify joist size, placement of joists and bridging, and connections to structure.
2. Visually inspect:
 - a. 20% of welds attaching web members to chords.
 - b. 100% of chord splices.

END OF SECTION

**SECTION 05 31 00
STEEL DECKING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. This Section specifies furnishing and installing steel decking at locations indicated on the Drawings; both roof decking and floor decking.

1.02 RELATED WORK

- A. Section 05 12 00: Structural Steel Framing.
- B. Section 05 44 00: Pre-Engineered Premanufactured Light Gauge Roof Trusses

1.03 REFERENCES

- A. American Iron and Steel Institute (AISI):
 - 1. AISI S100; North American Specification for the Design of Cold-Formed Steel Structural Members.
- B. ASTM International (ASTM):
 - 1. ASTM A108; Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 - 2. ASTM A653; Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 3. ASTM A780; Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - 4. ASTM A924; Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- C. American Welding Society (AWS):
 - 1. ANSI/AWS D1.1 Structural Welding Code - Steel.
 - 2. ANSI/AWS D1.3 Structural Welding Code – Sheet Steel.
- D. Steel Deck Institute (SDI):
 - 1. ANSI/SDI C: Standard for Composite Steel Floor Deck Slabs.
 - 2. ANSI/SDI RD: Standard for Steel Roof Deck.
 - 3. SDI COSP: Code of Standard Practice.
- E. U.S. Government – Code of Federal Regulations (CFR):
 - 1. 29 CFR 1926 Safety and Health Regulations for Construction.

1.04 SYSTEM DESCRIPTION

- A. Compute structural properties of roof and floor deck sections in accordance with the American Iron and Steel Institute Specification for the Design of Cold-Formed Steel Structural Members.

1.05 SUBMITTALS

- A. Manufacturer's specifications and installation instructions for each product specified. Include manufacturer's certification as may be required to show compliance with these specifications.
- B. Detailed drawings showing layout of deck panels, anchorage details and every condition requiring closure panels, special jointing, or other accessories.
- C. Welder Certificates: Submit certificates of welders employed on the work, verifying qualifications within the previous 12 months.
- D. Guarantee: Submit guarantee that all steel used in this project is American produced.
- E. An Independent Quality Assurance Testing and Inspection Agency (Approved Agency) shall submit inspection and testing reports required by this Section. Reports shall include data on type(s) of tests and inspections conducted and test and inspection results.
- F. Recycled Content Data: Submit written affidavits from the steel deck manufacturer indicating the percentage of post-industrial recycled content and post-consumer recycled content.
- G. Products
 - 1. Submit manufacturer's specifications and installation instructions for each product specified; include manufacturer's certification as required to show compliance with this specification.
 - a. Steel roof deck.
 - b. Composite floor deck.
 - c. Non-composite floor deck.
 - d. Mechanical fasteners.
 - e. Head stud type shear connectors.
 - f. Hanger attachment devices.
 - g. Galvanizing repair paint.

1.06 QUALITY CONTROL

- A. Codes and Standards:
 - 1. Comply with the provisions of the following codes and standards, except as otherwise shown or specified:
 - a. American Iron and Steel Institute (AISI):
 - 1) Specification for the Design of Cold-Formed Steel Structural Members.
 - b. American Welding Society (AWS):
 - 1) ANSI/AWS D1.3, Structural Welding Code - Sheet Steel.
 - c. Steel Deck Institute (SDI):
 - 1) ANSI/SDI C: Standard for Composite Steel Floor Deck Slabs.
 - 2) ANSI/SDI RD: Standard for Steel Roof Deck.
 - 3) SDI COSP: Code of Standard Practice.
 - d. OSHA Directive 29 CFR 1926.754.

- B. Installer Qualifications: Engage an experienced Installer who has completed steel deck similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- C. Welding Standards: Comply with applicable provisions of AWS D1.1 Structural Welding Code – Steel and AWS D1.3 Structural Welding Code – Sheet Steel.
 - 1. Certify each welder has satisfactorily passed AWS qualification tests within the last twelve (12) months for welding processes involved and, if pertinent, has undergone recertification.
- D. The completed deck installation shall be ready for the placement of concrete with only an allowance for minor alterations due to small floor penetrations that need to be coordinated with the mechanical, plumbing, and electrical disciplines. All closure sections, pour stops, and edge bent plates shall be installed. All deck edges shall be adequately supported and capable of supporting the weight of concrete and construction loading without additional deck alterations.
 - 1. At columns, install supplemental materials of sufficient strength to provide fall protection for personnel and to prevent objects from falling through to lower level.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Use special care in shipping steel deck.
 - 2. Ensure materials are delivered to the Site at times and intervals that facilitate uninterrupted progress of the Work and continuity of installation.
 - a. Deliver anchor rods and other anchorage items to be embedded in or attached to concrete, masonry, or other materials in ample time so the Work is not delayed.
- B. Storage and Handling Requirements:
 - 1. Store decking on platforms, skids, blocking, or other supports and with one end elevated.
 - 2. Protect decking from the weather with non-asphaltic waterproof covering, adequately ventilated to prevent condensation.
 - 3. Do not damage decking during handling or rigging.
 - a. Do not use decking for bulk storage or as a working platform for other construction materials.
 - b. Do not overload decking during installation and the entire construction period.
 - c. Do not place deck bundles on unbolted/unwelded building frames.
 - 4. During installation, do not locate bundles of uninstalled decking where they will overload supporting members.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Roof Deck:
 - 1. Fabricate panels conforming to ANSI/SDI RD-2010 Standard for Steel Roof Deck, and the following:
 - a. Galvanized-Steel Sheet: ASTM A653, Structural Quality Grade 33 or higher, G 60 zinc coated according to ASTM A924.
 - b. Deck Profile: Type WR, wide rib, 1½ inches deep.
 - c. Design Uncoated-Steel Thickness: 0.0358-inch.
 - d. Span Condition: Triple span or more.
 - e. Side Joints: Overlapped.

- B. Composite Floor Deck:
1. Fabricate panels with integrally embossed or raised pattern ribs and interlocking side laps, conforming to ANSI/SDI 1 C-2011 Standard for Composite Steel Floor Deck Slabs., the minimum section properties indicated, and the following:
 - a. Steel Sheet: ASTM A653, Structural Quality Grade 40 or higher, that receive a galvanized coating conforming to ASTM A924, G60 coating.
 - b. Profile Depth: 2 inches.
 - c. Design Uncoated-Steel Thickness: 0.0358 inch.
 - d. Span Condition: Triple span or more.
 - e. Side Joints: Overlapped.
- C. Accessories:
1. General: Provide accessory materials for steel deck that comply with requirements indicated and recommendations of the steel deck manufacturer.
 2. Mechanical Fasteners: Manufacturer's standard, corrosion-resistant, low-velocity, powder-actuated or pneumatically driven carbon steel fasteners; or self-drilling, self-threading screws that have a current approved ICC Evaluation Service Legacy Report.
 3. Rib Closure Strips: Manufacturer's standard vulcanized, closed-cell, synthetic rubber.
 4. Miscellaneous Roof Deck Accessories: Steel sheet, ridge and valley plates, finish strips, and reinforcing channels, of same material and thickness as roof deck.
 5. Pour Stops and Girder Fillers: Steel sheet, of same material as deck panels, and of thickness and profile indicated.
 6. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material and thickness as deck panels, unless otherwise indicated.
 7. Weld Washers: Manufacturer's standard uncoated-steel sheet weld washers, shaped to fit deck rib, 0.0598-inch thick with 3/8-inch minimum diameter pre-punched hole.
 8. Roof Sump Pans: Fabricate from single piece of 0.071-inch min. (14 gage) galvanized sheet steel with level bottoms and sloping sides to direct water flow to drain.
 - a. Provide sump pans of adequate size to receive roof drains and with bearing flanges not less than 3 inches wide.
 - b. Recess pans not less than 1½ inches below roof deck surface unless otherwise shown or required by deck configuration.
 - c. Cut holes for drains in the field.
 9. Flat Receiver Pan: Manufacturer's standard size, single-piece steel sheet, 0.071-inch thick minimum units, of same materials as deck panels. Cut holes for drains in the field.
 10. Steel Sheet Accessories: ASTM A653 Structural Quality minimum yield strength of 33ksi, G 60 coating class, galvanized according to ASTM A924.
 11. Galvanizing Repair Paint: High zinc-dust content paint for repair of damaged galvanized surfaces complying with ASTM A780.
 12. Preset Inserts: Manufacturer's standard, UL-labeled, single-piece preset inserts fabricated from either steel sheet galvanized according to ASTM A924, G 60 coating class, or zinc sheet, with removable covers.
 13. Hanger Attachment Devices: Manufacturer standard hanger attachment device.
- D. Headed Stud Type Shear Connectors (Studs): ASTM A108. Weld in accordance with AWS D1.1, Section 7, and meet the mechanical properties of Type B studs (Table 7.1).
- E. Deformed Bar Anchors: See Specification Section 03 20 00.

2.02 ACCEPTABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following or equal as approved by the Contracting Officer:
1. United Steel Deck; Canam Steel Corporation.
 2. Vulcraft Division of Nucor Corp.

3. New Millennium Building Systems, LLC.
4. Or approved equal.

2.03 SHOP FABRICATION

- A. Fabricate roof and floor panels in accordance with the requirements of ANSI/SDI Standards (Article 1.03B).
 1. Fabricate steel composite floor deck panels with integrally embossed or raised pattern ribs and interlocking side laps, and having at a minimum the section properties indicated.
- B. Provide decking free of lubricants and oils which would impair the adhesion of sprayed-on fireproofing.
- C. Accessory Fabrication:
 1. Steel Sheet Accessories:
 - a. Fabricate steel sheet accessories from steel sheet classified as Grade 33 or higher Structural Steel with Coating Designation G60 in accordance with ASTM A653, and within the tolerances specified in ASTM A924.
 2. Miscellaneous Roof Deck Accessories:
 - a. Fabricate miscellaneous roof deck accessories, such as steel sheet ridge and valley plates, finish strips, and reinforcing channels, from the same material and thickness as the roof deck.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine supporting framing and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of steel deck.
- B. Do not install steel deck on support framing insufficient to support the decking.

3.02 PREPARATION

- A. Locate decking bundles to prevent overloading of supporting members.

3.03 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary of ANSI/SDI Standards (Article 1.03B), manufacturer's recommendations, and requirements of this Section.
- B. Place deck panels on supporting framing and adjust to final position with ends accurately aligned and bearing on supporting framing before being permanently fastened.
 1. Place deck units in lengths to span 3 or more supports with interlapping side laps, unless otherwise indicated. Provide deck configurations complying with ANSI/ SDI Basic Design Specifications and as specified herein.
 2. Place deck panels flat and square and fasten to supporting framing without warp or deflection.
 3. Provide miscellaneous steel, as required, at columns and at beam/column moment connections to adequately support weight of concrete and construction loadings.
 4. Do not leave deck unattached at the end of day's work.

- C. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to the decking.
- D. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work.

3.04 ROOF DECK INSTALLATION

- A. Use #12 Screws edge ribs of roof deck panels to each steel supporting member as indicated on the Contract Drawings.
- B. Side Lap and Perimeter Edge Fastening:
 - 1. Fasten side laps and perimeter edges using the following method:
 - a. Mechanically fasten the side laps and perimeter edges of panels located between supports using self-drilling No. 12 diameter by ¾-inch long, galvanized carbon steel screws spaced no more than 12 inches apart.
 - 1) Verify that the deck side laps have been rolled during the manufacturing process to receive screws in the side lap joint.
 - 2. Do not use a button punching system.
- C. End Bearing:
 - 1. Unless otherwise noted on the Contract Drawings, install deck ends over the supporting framing with a minimum end bearing of 1½ inches and with end joints overlapped.
- D. Roof Sump Pans and Sump Plates:
 - 1. Install over openings provided in roof decking, and weld flanges to top of deck.
 - 2. Space welds not more than 12 inches apart with at least one weld at each corner.
- E. Miscellaneous Roof Deck Accessories:
 - 1. Install ridge and valley plates, finish strips, cover plates, end closures and reinforcing channels according to deck manufacturer's recommendations.
 - 2. Weld to substrate to provide a complete deck installation.
- F. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of decking, and support of other work as follows:
 - 1. Reinforce decking around openings having a 6-inch to 12-inch dimension in any direction by placing a steel sheet over the opening on the top of the decking, and fusion welding the sheet to the top surface of the deck.
 - a. Provide sheet steel of the same quality as the deck units and at least 12 inches wider and longer than the opening unless otherwise indicated on the Contract Drawings.
 - b. Provide welds at each corner and along each side spaced not more than 12 inches apart on center.
 - 2. For openings with a 12-inch or greater dimension in any direction, provide additional miscellaneous structural steel members on all sides of each opening as indicated on the Contract Drawings.
 - 3. If more than one penetration occurs in a deck panel, contact the Contracting Officer for reinforcement requirements.
 - 4. Do not cut unscheduled openings through the deck without the approval of the Contracting Officer.

- G. Do not support any other construction from the steel deck, including but not limited to suspended ceilings, light fixtures, ducts, piping, conduits, other equipment or utilities and similar items.

3.05 FLOOR DECK INSTALLATION – COMPOSITE DECKING

- A. Weld the edge ribs of floor deck panels to each steel supporting member using fusion welds or elongated welds of equal strength.
 - 1. Provide welds at each flute and on each side of lap joints at flutes.
 - 2. Weld Diameter: $\frac{3}{4}$ -inch, nominal.
 - 3. Weld Washers: Install weld washers at each weld location recommended by the deck manufacturer.
- B. Side Lap and Perimeter Edge Fastening:
 - 1. Butt the end joints of deck panels at support beams; do not overlap them.
 - 2. Mechanically fasten the side laps and perimeter edges of panels located between supports using self-drilling No. 12 diameter, carbon steel screws spaced no more than 24 inches apart.
- C. End Bearing:
 - 1. Install deck ends over the supporting framing with a minimum end bearing of 2 inches, and with end joints butted.
- D. Pour Stops and Girder Fillers:
 - 1. Weld steel sheet pour stops and girder fillers to the supporting structure according to ANSI/SDI recommendations unless otherwise indicated.
- E. Floor Deck Reinforcement and Closures:
 - 1. Weld steel sheet column closures, cell closures, and Z-closures to the floor deck according to ANSI/SDI recommendations to provide tight-fitting closures at the open ends of ribs and the sides of decking.
 - 2. Weld cover plates at changes in direction of the floor deck panels unless otherwise indicated.
 - 3. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of decking, and support of other work as follows:
 - a. For openings having a 6-inch to 12-inch dimension in any direction, reinforce the decking around the openings by placing a steel sheet over the opening on the top of the decking and fusion welding the sheet to the top surface of the deck.
 - 1) Provide sheet steel of the same quality as the deck units and at least 12 inches wider and longer than the opening unless otherwise indicated.
 - 2) Provide welds at each corner and spaced not more than 12 inches on center along each side.
 - b. For openings greater than 12 inches but less than 18 inches in any direction, reinforce the decking with steel as specified in Article 3.05E.3.a, and provide two No. 4 reinforcing steel bars on each side of the opening unless noted otherwise on the Contract Drawings.
 - c. For openings having an 18-inch or greater dimension in any direction, provide additional miscellaneous structural steel members on all sides of each opening as indicated on the Contract Drawings.
 - d. Where several penetrations in a floor deck panel must occur close together, space these openings so each penetration can be examined individually if possible. If the following criteria cannot be met, treat each opening as a long slot with a dimension equal to the distance between the outer edges of the outermost penetration.
 - 1) For a series of openings, each less than 6 inches, provide a minimum of 12 inches between the openings where the center to center dimension between the penetrations equals the largest opening diameter plus 12 inches.

- 2) For a series of openings, each greater than 6 inches but less than 10 inches, provide a minimum of 18 inches between penetrations.
 - 3) For a series of openings, each greater than 10 inches but less than 18 inches, notify the Contracting Officer of the locations prior to placing concrete.
 - e. Do not cut unscheduled openings through the deck without the approval of the Contracting Officer.
 - f. If questions occur related to the type/amount of reinforcement to be provided at floor openings, contact the Contracting Officer prior to placing concrete.
- F. Shear Connectors: See Article 3.06 this Specification.
- G. Interface with Other Work:
 - 1. Provide complete deck installations ready for concrete placement onto the deck, except for minor alterations required to accommodate small floor penetrations.
 - a. Coordinate the small penetrations with the mechanical, plumbing, and electrical disciplines.
 - b. Install closure sections, pour stops, and edge bent plates as required.
 - c. Provide adequately supported deck edges capable of supporting the weight of the concrete and construction loading without additional deck alterations.
 - d. At columns, install supplemental materials of sufficient strength to provide fall protection for personnel and to prevent objects from falling through the deck to lower levels.
 - 2. Placing Topping Materials onto Deck Panels:
 - a. Prior to placing concrete or other topping materials onto the metal deck, submit the pour sequences, maximum square footage of each pour, and pour joint locations to the Contracting Officer for approval.
 - b. Prior to placing concrete or other topping materials onto the deck panels, refer to the Contract Drawings for guidelines to determine if the deck must be temporarily shored during placement or concreting operations; and remove foreign matter from the deck panels.
 - c. Place concrete onto the deck panels in a uniform manner over the supporting structure from a low level to avoid impact loading.
 - d. Spread the concrete placed toward the center of the deck span.
 - e. Finish slabs in accordance with the requirements specified in Section 03 30 00, Cast-in-Place Concrete, and on the Contract Drawings.
 - 3. Hangers Attached to Deck Units:
 - a. For supporting ceilings, air ducts, diffusers, or lighting fixtures, install approved hanger attachment devices where hangers are to be attached to deck units.
 - 1) Locate hanger attachment devices at not more than 24 inches apart on center in both directions, not over 9 inches from walls at ends, and not more than 12 inches from walls at sides, unless otherwise indicated.
 - b. For mounting mechanical, plumbing, and electrical equipment, install adjustable metal deck hanger rod assemblies in the deck prior to placing slab concrete.
 - 1) The maximum hanger loads and minimum hanger spacing are defined on the Contract Drawings.
 - 2) Where load and spacing criteria cannot be met, install supplemental framing.

3.06 SHEAR CONNECTORS

- A. General: Installation shall be in accordance with AWS Code using automatic welding equipment. Clean welding surface before installing studs.
- B. Location: See the Drawings for spacing and arrangement.
- C. Weld shear connectors through deck to support framing according to AWS D1.1 and manufacturer's instructions. Butt end joints of deck panels; do not overlap.
- D. At start of each day's production welding period and after welding equipment has been moved or changed, the Prime Contractor shall weld and test two test studs in the presence of the Independent Quality Assurance Testing and Inspection Agency (Approved Agency).
 - 1. These studs shall be bent to an angle of 30 degrees from vertical by striking with a hammer.
 - 2. If failure occurs in weld zone of either stud, correct or adjust welding operation.
 - 3. Two consecutive studs shall be welded and found satisfactory before production welding can begin.
- E. Replace studs which fail inspection by Approved Agency at no expense to the Government.
- F. Break ferrules away from all studs.
- G. Do not weld when base metal temperature is below -18 degrees C or when welding surface is wet.
- H. Shear connectors shown on Drawings are based on deck types and sizes specified.
 - 1. Should any deck be installed with characteristics different than specified deck, number of shear connectors shall be increased to provide equivalent capacity at no additional expense to the Government.

3.07 QUALITY ASSURANCE TESTING AND INSPECTION

- A. An Independent Testing and Inspection Agency (Approved Agency) shall be engaged to perform field inspections, quality control testing, and prepare test reports.
 - 1. The Approved Agency shall conduct and interpret test results.
 - 2. Written reports on all tests and inspections shall be provided immediately after work is performed. The reports shall state test specimens either comply with requirements or deviate from them.
- B. Provide access for the Approved Agency to places where work is being performed so required inspection and testing can be accomplished.
- C. Inspections:
 - 1. After placing the decking but prior to placing topping materials, inspect deck for tears, dents, and other damage that may prevent the deck from acting as a form or diaphragm.
 - 2. All welds to be visually examined.
- D. In addition to the tests required by Article 3.06 of the Section, shear connector welds will be inspected and tested by the Approved Agency according to the requirements of AWS D1.1 for stud welding and as follows:
 - 1. Certify welders, conduct inspections and tests as required, record types and locations of defects found in work, record work required and performed to correct deficiencies.
 - 2. All shear connector welds will be visually inspected.

3. In addition to visual inspection, 10% (minimum) of field-welded shear connectors will be inspected and tested according to requirements of AWS D1.1 for stud welding and as follows:
 - a. Bend tests will be performed when visual inspections reveal either less than a continuous 360-degree flash or welding repairs to any shear connector.
 - b. Tests will be conducted on additional shear connectors when weld fracture occurs on shear connectors already tested, according to requirements of AWS D1.1.
- E. Remove and replace work that does not comply with specified requirements.
- F. The Contractor shall correct deficiencies in steel deck work and shear connector placement that inspections and test reports have indicated to be not in compliance with requirements.
 1. The Approved Agency will perform additional tests, at the Contractor's expense, as necessary to reconfirm any noncompliance of original work and to show compliance of corrected work.

3.08 REPAIRS AND PROTECTION

- A. Upon completion of decking placement, and prior to placement of topping materials, inspect for tears, dents or other damage that may prevent the deck from acting as a form or diaphragm. Repairs or replacement shall be made prior to placement of topping materials.
- B. Galvanizing Repairs: Prepare and repair damaged galvanized coatings with galvanized repair paint according to ASTM A780 and the manufacturer's instructions.
- C. Provide final protection and maintain conditions to ensure steel decking is without damage or deterioration at time of Pre-Final Completion.

3.09 CLEANING

- A. Prior to placing concrete or other topping materials onto the deck panels, remove all soil, debris, standing water, loose mill scale, and other foreign matter from the deck panels.

END OF SECTION

SECTION 05 44 00
PRE-ENGINEERED, PREFABRICATED LIGHT GAUGE STEEL ROOF TRUSSES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Section includes pre-engineered, pre-fabricated light gauge cold formed steel framing elements, anchorage, bracing, and bridging.

1.02 RELATED SECTIONS:

- A. Section 05 31 00: Metal Deck.
- B. Section 07 62 00: Sheet Metal Flashing and Trim.

1.03 REFERENCES

- A. American Iron and Steel Institute (AISI):
 - 1. AISI S100: North American Specification for the Design of Cold-Formed Steel Structural Members.
 - 2. AISI S201-17: North American Standard for Cold-Formed Steel Framing – Product Data 2017
 - 3. AISI S202-15: Code of Standard Practice for Cold-Formed Steel Framing, 2015
 - 4. AISI S240-15: North American Standard for Cold-Formed Steel Framing, 2015.
- B. ASTM International (ASTM):
 - 1. ASTM A370: Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
 - 2. ASTM A653/A653M: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.”
 - 3. ASTM A780: Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- C. American Welding Society (AWS):
 - 1. AWS D1.1 Structural Welding Code - Steel.
 - 2. AWS D1.3 Structural Welding Code - Sheet Steel.
- D. Whole Building Design Guide
 - 1. UFC 3-301-10, 2023 with Change 3.
- E. International Code Council (ICC):
 - 1. International Building Code® (IBC) 2021.
- F. American Society of Civil Engineers (ASCE):
 - 1. ASCE 7-16 with Change 1; Minimum Design Loads for Buildings and Other Structures.
- G. Cold Formed Steel Engineers Institute (CFSEI)
 - 1. CFSEI 551e – Design Guide for Permanent Bracing of Cold Formed Steel Trusses.
- H. The Society for Protective Coatings (SSPC):
 - 1. SSPC Paint 15 – Steel Joist Shop Paint
 - 2. SSPC Paint 20 – Zinc-Rich Primers (Type I – Inorganic and Type II – Organic).

1.04 SYSTEM DESCRIPTION

- A. Provide design of trusses by Truss Component Manufacturer, using design methodologies recommended in the AISI and CFSEI references.
- B. Structural Performance: Design, engineer, fabricate, and erect cold-formed steel trusses to withstand specified design loads within limits and under conditions indicated unless more stringent requirements are imposed by the governing code; these requirements take precedence when more stringent than the governing code. Reference Design Criteria in Contract Document Drawing number S001. Any discrepancies, use the more conservative loading.
 - 1. Live/Snow Loads on Roof Systems: Use 25 psf plus sliding or drifting snow loads. Consider unbalanced snow load in design cases.
 - 2. Dead Load – Total of all permanently installed material including roofing, insulation, decking, ceiling materials, accessories, and equipment that is in fixed position equaling 25 psf total dead load.
 - 3. Miscellaneous Dead Load: Truss and portions thereof shall resist the most critical effects resulting from one of the following: (1) 5 psf vertical load applied to the top chord, (2) a 10 psf vertical load applied to the bottom chord, or (3) a 5 psf vertical load applied to both chords simultaneously.
 - a. Verify the bottom truss chord can support a 500 pound concentrated load fastened anywhere along the length of the truss.
 - 4. Wind Loads (per IBC 2021/ASCE 7-16): Exposure C, Importance Factor $I=1.0$, Wind Velocity = 110 miles per hour (Vult).
 - 5. Seismic Loads: Design and size the components to withstand seismic loads and sway displacement as calculated in accordance with IBC 2021/ASCE 7-16 w/change 1
 - 6. Deflections:
 - a. Vertical Live Load Deflection: 1/360 of the span maximum.
 - b. Total Design Load Deflection: 1/240 of the span maximum.
 - 7. 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 (range) of 120° F.
 - 8. Truss system, with framing components and accessories, shall provide a complete framing system ready for roofing material installation.
- C. Permanent Bracing System Requirements:
 - 1. A permanent diagonal bracing system, to resist the lateral loads imposed on the completed building by wind forces, shall be designed and provided by the Truss Supplier as part of the roof truss system.
 - 2. The designed bracing system shall transfer cumulative lateral loads that act on the vertical projected face of the roof system to the shear walls indicated on the drawings.
- D. Coordination:
 - 1. Truss supplier shall provide bearing attachments with all necessary anchors and uplift connections.
 - 2. Truss supplier shall provide and coordinate all bracing, bridging, and blocking members.

1.05 SUBMITTALS

- A. Submit manufacturer's product data and installation instructions for each type of cold-formed steel framing and accessory required.
- B. Submit shop drawings showing member, type, location, spacing, size, and gage of members; method of attachment to supporting members; and all necessary erection details. Indicate

supplemental bracing, strapping, splices, bridging, accessories, and details required for proper installation.

- C. Submit detailed roof truss layouts.
- D. Submit truss drawings and calculations, sealed and signed by a qualified registered Professional Engineer in the Commonwealth of Pennsylvania, verifying truss' ability to meet local code and design requirements. Include:
 - 1. Description of design criteria.
 - 2. Engineering analysis depicting member stresses and truss deflection.
 - 3. Truss member sizes and gauges and connections at truss joints.
 - 4. Truss support reactions.
 - 5. Top chord, Bottom chord, and Web bracing requirements.
 - 6. Permanent Bracing System.
 - 7. Truss connections to the concrete structure including uplift resistance calculation.
- E. Mill Certifications: Submit mill certifications for steel delivered to site.
- F. Guarantee: Submit guarantee all steel used in this project is American produced.
- G. An Independent Quality Assurance Testing and Inspection agency shall submit inspection and testing reports required by this Section. Reports shall include data on type(s) of tests and inspections conducted, and test and inspection results.

1.06 QUALITY ASSURANCE

- A. Fabricator Qualifications: Fabrication shall be performed by a cold-formed steel truss fabricator with experience designing and fabricating cold-formed steel truss systems equal in material, design, and extent to the systems required for this Project.
 - 1. Cold-Formed steel truss system installation shall be performed by an experienced installer approved by the steel truss system fabricator. Installer shall have experience equal to or greater to systems required for this project.
- B. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code – Steel" and AWS D1.3 "Structural Welding Code – Sheet Steel".
 - 1. Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure."
- C. Pre-Fabrication Meetings:
 - 1. Meet at job site prior to scheduled beginning of fabrication activities of this section to review requirements of this section.
 - 2. Attendees:
 - a. Truss fabricator.
 - b. Installer (of this section).
 - c. Other entities directly affecting, or affected by, construction activities of this section including but not limited to:
 - 1) The installer of the support framing.
 - 2) The installer of the mechanical systems.
 - d. Representative of the Contracting Officer.
 - 3. Review potential interface conflicts, coordinate layout and support provisions for the trusses.
 - 4. Regular job progress and coordination meetings as required.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's unopened containers or bundles, fully identified by name, brand, type, and grade. Exercise care to avoid damage during unloading, storing, and erection.
- B. Store trusses on blocking, pallets, platforms or other supports off the ground and in an upright position sufficiently braced to avoid damage from excessive bending.
- C. Protect trusses and accessories from corrosion, deformation, damage, and deterioration when stored at job site. Keep trusses free of dirt and other foreign matter.
- D. Store trusses in a manner to allow draining of water and water buildup. Additionally, prevent ponding of water on truss members.

1.08 PROJECT CONDITIONS

- A. During construction, adequately distribute all loads applied to trusses so as not to exceed the carrying capacity of any one joist, truss, or other component.
- B. Construction loads shall not be placed on unbraced trusses.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Manufacturer:
 - 1. TrusSteel Division of Alpine Engineered Products Inc.
 - 2. Aegis Metal Framing Division of Dietrich Metal Framing.
 - 3. All Span Light Gauge Steel Truss System.
 - 4. Or approved equal.

2.02 COMPONENTS

- A. Provide manufacturer's standard steel truss members, bracing, bridging, blocking, reinforcements, fasteners, and accessories with each type of steel framing required, as recommended by the manufacturer for the applications indicated and as needed to provide a complete light gauge cold formed steel truss system.
- B. Shop Fabricate from cold formed steel components in accordance with shop drawings, using jiggling systems to ensure consistent component placement and alignment components and to maintain specified tolerances as indicated below.
- C. Field fabrication of trusses is strictly prohibited unless performed by an authorized fabricator as determined by the Contracting Officer. This fabricator must use shop assemblers and proper jiggling systems.

2.03 MATERIALS

- A. Materials:
 - 1. All component gauges: Fabricate components of structural quality steel sheet per ASTM A653 with minimum yield strength of 50,000 psi.
 - 2. Bracing, bridging and blocking members: Fabricate components of commercial quality steel sheet per ASTM A653 with minimum yield strength of 33,000 psi.

- B. Steel Truss Members: Provide sizes, shapes and gages required to suit design indicated on shop drawings:
 - 1. Design Uncoated-Steel Thickness: 20 ga., 0.0350 inch.
 - 2. Design Uncoated-Steel Thickness: 18 ga., 0.0460 inch.
 - 3. Design Uncoated-Steel Thickness: 16 ga., 0.0570 inch.
 - 4. Design Uncoated-Steel Thickness: 14 ga., 0.0730 inch.
- C. Finish: Provide components with protective zinc coating complying with ASTM A653, minimum G60 coating.
- D. Fastenings:
 - 1. Manufacturer recommended self-drilling, self-tapping screws with corrosion-resistant plated finish. Fasteners shall be of sufficient size and number to ensure the strength of the connection.
 - 2. Welding: Comply with AWS D1.1 when applicable and AWS D1.3 for welding base metals less than 1/8" thick.
 - 3. Other fasteners as accepted by truss engineer.

2.04 FABRICATION

- A. Factory fabricate cold-formed steel trusses plumb, square, true to line, and with connections securely fastened, according to manufacturer's recommendations and the requirements of this Section.
 - 1. Fabricate truss assemblies in jig templates.
 - 2. Cut truss members by sawing or shearing or plasma cutting.
 - 3. Fasten cold-formed steel truss members by welding or screw fastening or other methods as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to cold-formed steel truss component manufacturer's instructions with screw penetrating joined members by not less than 3 exposed screw threads.
- B. Care shall be taken during handling, delivery, and erection. Brace, block, or reinforce truss as necessary to minimize member and connection stresses.
- C. Fabrication Tolerances: Fabricate trusses to a maximum allowable tolerance variation from straight, plumb, level, and true to line of 1:960 [1/8 inch in 10 feet], and as follows:
 - 1. Spacing: Space individual trusses no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Squareness: Fabricate each cold-formed steel truss to a maximum out-of-square tolerance of 1/8 inch.
 - 3. Overall Length: Fabricate trusses to less than plus or minus 1/2 inch from design length.
 - 4. Overall Height: Fabricate trusses to less than plus or minus 1/2 inch from design height.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine structure, substrates, and installation conditions. Do not proceed with cold-formed steel truss installation until unsatisfactory conditions have been corrected.
 - 1. Written notification of unsuitable conditions shall be submitted by the Installer.

- B. Installation constitutes acceptance of existing conditions and responsibility for satisfactory performance.

3.02 INSTALLATION, GENERAL

- A. General:
 - 1. Erection of trusses, including proper handling, safety precautions, temporary (construction) bracing, permanent bracing and other safeguards or procedures, are the responsibility of the Contractor and Contractor's installer.
 - 2. Exercise care and provide erection bracing required to prevent toppling of trusses during erection.
- B. Erect trusses with plane of truss webs vertical and parallel to each other, accurately located at design spacing indicated on Truss Fabricator's shop drawings.
- C. Provide proper lifting equipment suited to sizes and types of trusses required, applied at lift points recommended by truss fabricator. Exercise care to avoid damage to truss members during erection and to keep horizontal bending of the trusses to a minimum.
- D. Provide framing anchors as indicated or accepted on the engineering design drawing or erection drawings. Anchor trusses securely at bearing points.
- E. Install roof framing and accessories plumb, square, true to line, and with connections securely fastened, according to manufacturer's recommendations.
 - 1. DO NOT cut truss members without prior approval of truss engineer.
 - 2. Fasten cold-formed steel roof framing by welding or screw fastening, as standard with fabricator. Wire tying of roof framing is not permitted.
 - a. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to cold-formed roof framing manufacturer's instructions with screw penetrating joined members by not less than 3 exposed screw threads.
 - c. Install roof framing in one-piece lengths, unless splice connections are indicated.
 - d. Provide temporary bracing and leave in place; bracing shall not be removed.
- F. Erection Tolerances: Install trusses to a maximum allowable tolerance variation from plumb, level, and true to line of 1:960 [1/8 inch in 10 feet] and as follows:
- G. Space individual trusses no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.03 ROOF TRUSS INSTALLATION

- A. Install, bridge, and brace trusses according to manufacturer's recommendations and requirements of this Section.
- B. Trusses shall be spaced at 24 inches on center unless noted otherwise on the Contract Drawings.
- C. Do not alter, cut, or remove truss members or connections of truss members.
- D. Erect trusses with plane of truss webs plumb and parallel to each other, align, and accurately position at spacing indicated.

- E. Erect trusses without damaging truss members or connections.
- F. Align truss bottom chords with load-bearing studs or continuously reinforce track to transfer loads to structure. Anchor trusses securely at all bearing points.
- G. Install continuous bridging and permanent truss bracing per truss design requirements prior to the application of any loads.
- H. Install necessary roof cross and diagonal bracing per truss designer's recommendations.

3.04 REPAIRS AND PROTECTION

- A. Repair or replace damaged chords and web members as directed and approved in writing by the Contracting Officer and by the Truss Fabricator in advance of the work being performed.
- B. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanizing repair paint according to ASTM A780 and the manufacturer's instructions.

3.05 QUALITY ASSURANCE TESTING

- A. An Independent Quality Assurance Testing and Inspection Agency shall be engaged to perform field inspections, quality control testing, and prepare test reports.
 - 1. The Agency shall conduct and interpret test results.

END OF SECTION

**SECTION 05 50 00
METAL FABRICATIONS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. This Section specifies furnishing and installing miscellaneous steel at locations indicated on the Drawings.

1.02 RELATED SECTIONS:

- A. Individual miscellaneous metal items as specified in various other Sections of the general construction Specifications.

1.03 REFERENCES

- A. American Society For Testing and Materials:
1. ASTM A36, Structural Steel.
 2. ATSM A53, Carbon Steel Pipes
 3. ASTM A307, Carbon Steel Externally Threaded Standard Fasteners.
 4. ASTM A320, Alloy-Steel Bolting Materials for Low-Temperature Service.
 5. ASTM A325, High-Strength Bolts for Structural Steel Joints.
 6. ASTM A480, Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 7. ASTM A489, Carbon Steel Eyebolts.
 8. ASTM A563, Carbon and Alloy Steel Nuts.
 9. ASTM A668, Steel Forgings, Carbon and Alloy, for General Industrial Use.
 10. ASTM F436, Hardened Steel Washers.
- B. American Welding Society: AWS D1.1 Structural Welding Code.
- C. Federal Specifications:
1. Fed. Spec. FF-S-92a, Screws, Machine: Slotted, Cross Recessed or Hexagon Head.
 2. Fed. Spec. FF-S-325, Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry) Group II (Shield, Expansion Bolt Anchor) Type 4 (Wedge expansion anchors) Class 1 (One piece steel expander with cone taper integral with stud).

1.04 SUBMITTALS

- A. Shop Drawings and Product Data:
1. Shop drawings shall identify the detail as indicated on the Contract Drawings and be complete as to the detail of the product and location in the project, the size of members, the methods of joining various components, the quantity, finish, the location and type of anchors and necessary measurements.
 2. Shop assemblies which require markings for erection identification shall have easy-to-read markings on the shop and erection drawings.
 3. Note on shop drawings variations in tolerances or clearances between various products.
 4. Use standard welding symbols of the American Welding Society on shop drawings.
 5. Furnish setting diagrams, templates, and directions for the installation of metal fabrications.
 6. Submit product data on type of finish paint system for both shop painting and field touch-up painting.
 7. Submit current Approved ICC Evaluation Reports for all expansion and adhesive anchors.

1.05 QUALITY ASSURANCE

- A. Welder Qualifications: Welds shall be made only by welders, tackers, and welding operators who are currently qualified by tests as prescribed in the Structural Welding Code, AWS D1.1 of the American Welding Society to perform the type of work required.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Store steel above the ground surface on platforms, skids, blocking or other supports.
- B. Protect from exposure to conditions that produce rust.
- C. Store beams with webs vertical.
- D. Handle steel so no parts are bent, broken, or otherwise damaged and avoid damage to other material and work.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Miscellaneous Metal: Steel used for miscellaneous metal applications shall conform to ASTM A36.
 - 1. Steel Shapes, Plates and Bars: ASTM A36.
 - 2. Checkered Steel Plate: ASTM A36 with raised pattern to provide non-slip wearing surface. The thickness of the plate indicated on the Contract Drawings does not include raised portion.
 - 3. Stainless Steel Shapes and Bars: ASTM A276, AISC Type 304 and 316.
- B. Fasteners, Anchors and Welding Materials:
 - 1. Machine Screws: AISC Type 304 stainless steel conforming to Fed. Spec. FF-S-92a.
 - 2. Stainless Steel Anchor Bolts: ASTM A320 Grade B8, AISC Type 304.
 - 3. Standard Steel Bolts, Nuts and Washers: ASTM A307.
 - 4. Steel Expansion Anchors and Stainless Steel Expansion Anchors: Provide anchors that meet ACI 318 appendix D requirements for cracked concrete and have Approved ICC Evaluation Report, such as Hilti Kwik-Bolt TZ, www.hilti.com, Simpson Strong Tie, Strong-Bolt, www.simpsonanchors.com.
 - 5. U-Bolts: Carbon steel with National Coarse Threads and zinc-coated finish.
 - 6. Eyebolts: Carbon steel with National Coarse Threads and zinc-coated finish: ASTM A489.
 - 7. High-Strength Structural Steel Bolts, Nuts and Washers:
 - a. ASTM A325 Specification for Bolts.
 - b. ASTM A563 Specification for Carbon and Alloy Steel Nuts.
 - c. ASTM F436 Specification for Hardened Steel Washers for Use with High-Strength Bolts.
 - 8. Steel Anchor Bolts: Shapes as indicated, ASTM A307.
 - 9. Epoxy Adhesive Anchoring System: Provide adhesive anchors that meet ACI 318 appendix D requirements for cracked concrete and that have a current Approved ICC Evaluation Report. The adhesive anchor setting system shall be composed of anchors and fasteners as specified, and a self-contained cartridge system capable of dispensing both epoxy components in the proper mixing ratio.
 - a. Standard Anchor Rod Assembly: Chamfered end threaded stud rod of ASTM A 307 steel with nut and washer. Stud size as indicated on Drawings.
 - b. Stainless Steel Anchor/Fastener: Chamfered end threaded stud rod of AISI Type 304 stainless steel, with nut and washer of AISI Type 316 stainless steel.

- c. Adhesive Cartridge: The dual cartridge shall contain both hardener and resin and shall be dispensed from the dual cartridge through a static mixing nozzle.
 - 1) Two-component, 100 percent solid, non-sag paste, insensitive to moisture and meeting requirements of ASTM C 881, Type IV, Grade 3. Class A, B, and C. Shrinkage during cure shall be .00051in./in. maximum in accordance with ASTM D 2566. Compressive strength of 71 MPa [10,300 psi] minimum in accordance with ASTM D 695.
 - 2) The pre-mixed adhesive shall be injected directly into the prepared anchor hole. The anchor/fastener shall be inserted in the adhesive in accordance with the adhesive manufacturer's installation instructions.
- d. Acceptable Manufacturers:
 - 1) Hilti HIT RE 500-SD, www.hilti.com.
 - 2) Simpson XP, www.simpsonanchors.com
- 10. Welding Electrodes: Table 4.1.1 of AWS D1.1 as required for applicable base metals and welding process.

C. Stainless Steel Plate, Sheet and Strip: ASTM A167 and A480.

D. Shop Paint: Surface preparation and painting in accordance with Section 09 90 00.

2.02 FABRICATION

- A. Insofar as possible, fit and shop assemble metal fabrications, ready for installation.
- B. Fabricate in accordance with details, approved shop drawings and referenced standards.
- C. Drill or punch holes required for the attachment of work of other trades and for bolted connections. Burned holes are not acceptable.
- D. Welding shall be in accordance with AWS D1.1.
- E. Dress smooth welds and sharp corners.
- F. Make work square, plumb, straight, and true.

2.03 SHOP PAINTING

- A. Surface Preparation and painting in accordance with Section 09 90 00.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Inspect the installed work of other trades and verify that such work is complete to the point where this work may properly commence.

3.02 PREPARATION

- A. Field Measurements: Verify measurements in field before fabrication.

3.03 ERECTION

- A. Erect and install miscellaneous metal and metal fabrications in accordance with details, approved shop drawings and referenced standards aligning straight, plumb and level within a tolerance of one in 200.
- B. Provide suitable temporary braces and stays to hold metal fabrications in position until permanently secured.
- C. Draw threaded bolt connections up tight with lock washers or other means to prevent loosening. Screw fasteners in exposed or finished surfaces may be slot or Phillips head type, but in either case, screws must be countersunk design.
- D. Erect miscellaneous structural steel in accordance with the Drawings, pertinent regulations and referenced AISC standards.

3.04 INSTALLATION

- A. Expansion Anchor Installation:
 - 1. General: In general, install expansion anchors in strict accordance with manufacturer's instructions and in accordance with the following.
 - 2. Drilling Holes: Use rotary hammer type drill and make drill holes to the required diameter and depth as consistent with anchor manufacturer's instructions for size of anchors being installed.
 - 3. Minimum Embedment: Embed expansion anchors to six bolt diameters minimum, unless otherwise indicated on Drawings.
- B. Adhesive Anchor Installation:
 - 1. General: In general, install adhesive anchors in strict accordance with manufacturer's instructions and in accordance with the following.
 - 2. Drilling Holes: Use rotary hammer type drill and make drill holes to the required diameter and depth as consistent with anchor manufacturer's instructions for size of anchors being installed.
 - a. Prior to setting cartridge and anchor stud clean drilled holes free of loose material by vacuum process, finishing with a blast of compressed air, and cover hole until actual use.
 - 3. Anchor Rod Installation: Following cartridge installations in in-prepared drill holes, set anchor rod to the required depth. Set anchor rod truly perpendicular (normal) to the base plate of item being anchored.
 - 4. Minimum Embedment Table:

Adhesive Anchor Diam. (Inches)	3/8	1/2	5/8	3/4	7/8	1
Embedment Depth (Inches)	3-1/2	4-1/4	5	6-5/8	7-1/2	8

3.05 FIELD TOUCH-UP PAINTING

- A. Provide field touch-up painting in accordance with Section 09 90 00.

END OF SECTION

**SECTION 05 51 00
METAL STAIRS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Stairs with metal treads.
- B. Structural steel stair framing and supports.
- C. Handrails and guards.

1.02 REFERENCE STANDARDS

- A. ASTM A6/A6M - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
- B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- C. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- E. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- F. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- G. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
- H. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable.
- I. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- J. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength.
- K. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
- L. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification.
- M. AWS D1.1/D1.1M - Structural Welding Code - Steel.
- N. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer.
- O. SSPC-SP 2 - Hand Tool Cleaning.

1.03 SUBMITTALS

- A. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
 - 2. Include the design engineer's seal and signature on each sheet of shop drawings.
- B. Design Data: As required by authorities having jurisdiction.
- C. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.

1.04 QUALITY ASSURANCE

- A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in the Commonwealth of Pennsylvania, or personnel under direct supervision of such an engineer.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Unit Stair Towers:
 - 1. Alfab, Inc: www.alfabinc.com/#sle.
 - 2. American Stair, Inc: www.americanstair.com/#sle.
 - 3. Construction Specialties, Inc: www.c-sgroup.com/#sle.
 - 4. Pacific Stair Corporation: www.pacificstair.com/#sle.

2.02 METAL STAIRS - GENERAL

- A. Metal Stairs: Provide stairs of the design specified, complete with landing platforms, vertical and horizontal supports, railings, and guards, fabricated accurately for anchorage to each other and to building structure.
 - 1. Regulatory Requirements: Provide stairs and railings that comply with most stringent requirements of local, state, and federal regulations; where requirements of Contract Documents exceed those of regulations, comply with Contract Documents.
 - 2. Handrails: Comply with applicable accessibility requirements of ADA Standards.
 - 3. Structural Design: Provide complete stair and railing assemblies that comply with the applicable local code.
 - 4. Dimensions: As indicated on drawings.
 - 5. Shop assemble components; disassemble into largest practical sections suitable for transport and access to site.
 - 6. No sharp or rough areas on exposed travel surfaces and surfaces accessible to touch.
 - 7. Separate dissimilar metals using paint or permanent tape.
- B. Metal Jointing and Finish Quality Levels:
 - 1. Commercial: Exposed joints as inconspicuous as possible, whether welded or mechanical; underside of stair not covered by soffit IS considered exposed to view.
 - a. Welded Joints: Intermittently welded on back side, filled with body putty, and sanded smooth and flush.
 - b. Welds Exposed to View: Ground smooth and flush.
 - c. Mechanical Joints: Butted tight, flush, and hairline.
 - d. Bolts Exposed to View: Countersunk flat or oval head bolts; no exposed nuts.
 - e. Exposed Edges and Corners: Eased to small uniform radius.
 - f. Metal Surfaces to be Painted: Sanded or ground smooth, suitable for satin or matte finish.
- C. Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.
- D. Anchors and Related Components: Same material and finish as item to be anchored, except where specifically indicated otherwise; provide all anchors and fasteners required.

2.03 METAL STAIRS WITH METAL TREADS

- A. Jointing and Finish Quality Level: Commercial, as defined above.
- B. Risers: Closed.
- C. Treads: Steel plate with abrasive coating.
 - 1. Tread Thickness: 1/4 inch, minimum.
 - 2. Factory Fabricated Tread and Nosing: Manufacturer's standard, with integral tread, nosing, abrasive filler and factory applied finishes.
 - 3. Anchorage to Stringers: Welded or bolted to carrier angles welded or bolted to stringers.

- D. Risers: Steel sheet.
 - 1. Riser Thickness: As required by design; 14 gauge, 0.075 inch minimum.
 - 2. Riser/Nosing Profile: Sloped riser with rounded nosing of minimum radius.
- E. Stringers: Rolled steel channels.
 - 1. Stringer Depth: 10 inches.
 - 2. End Closure: Sheet steel of same thickness as risers welded across ends.
- F. Landings: Same construction as treads, supported and reinforced as required to achieve design load capacity.
- G. Railings: Steel pipe railings.
- H. Finish: Shop- or factory-prime painted.

2.04 HANDRAILS AND GUARDS

- A. Wall-Mounted Rails: Round pipe or tube rails unless otherwise indicated.
 - 1. Outside Diameter: 1-1/4 inch, minimum, to 1-1/2 inches, maximum.
- B. Guards:
 - 1. Top Rails: Round pipe or tube rails unless otherwise indicated.
 - a. Outside Diameter: 1-1/4 inch, minimum, to 1-1/2 inches, maximum.
 - 2. Infill at Pipe Railings: Pipe or tube rails sloped parallel to stair.
 - a. Outside Diameter: 1 inch.
 - b. Material: Steel pipe or tube, round.
 - c. Vertical Spacing: Maximum 4 inches on center.
 - d. Jointing: Welded and ground smooth and flush.
 - 3. End and Intermediate Posts: Same material and size as top rails.
 - a. Horizontal Spacing: As indicated on drawings.
 - b. Mounting: Welded to top surface of stringer.

2.05 MATERIALS

- A. Steel Sections: ASTM A36/A36M.
- B. Steel Tubing: ASTM A500/A500M or ASTM A501/A501M structural tubing, round and shapes as indicated.
- C. Steel Plates: ASTM A6/A6M or ASTM A283/A283M.
- D. Pipe: ASTM A53/A53M Grade B Schedule 40, black finish.
- E. Ungalvanized Steel Sheet: Hot- or cold-rolled, except use cold-rolled where finished work will be exposed to view.
 - 1. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Designation CS (commercial steel).
 - 2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Designation CS (commercial steel).

2.06 ACCESSORIES

- A. Factory Fabricated Stair Tread and Nosing:
 - 1. Materials: Steel.
 - a. Finish: Natural sand cast finish.
- B. Steel Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, and galvanized to ASTM A153/A153M where connecting galvanized components.
- C. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- D. Shop and Touch-Up Primer: SSPC-Paint 15, and comply with VOC limitations of authorities having jurisdiction.

2.07 SHOP FINISHING

- A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- B. Do not prime surfaces in direct contact with concrete or where field welding is required.

- C. Prime Painting: Use specified shop- and touch-up primer.
 - 1. Preparation of Steel: In accordance with SSPC-SP 2 Hand Tool Cleaning.
 - 2. Number of Coats: One.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

- A. When field welding is required, clean and strip primed steel items to bare metal.
- B. Supply items required to be embedded in masonry with setting templates.

3.03 INSTALLATION

- A. Install components plumb and level, accurately fitted, free from distortion or defects.
- B. Provide anchors, plates, angles, hangers, and struts required for connecting stairs to structure.
- C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- D. Provide welded field joints where specifically indicated on drawings. Perform field welding in accordance with AWS D1.1/D1.1M.
- E. Other field joints may be either welded or bolted provided the result complies with the limitations specified for jointing quality levels.
- F. Obtain approval prior to site cutting or creating adjustments not scheduled.
- G. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.

END OF SECTION

**SECTION 05 51 33
METAL LADDERS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Shop-fabricated metal ladders.

1.02 REFERENCE STANDARDS

- A. ANSI A14.3 - American National Standard for Ladders -- Fixed -- Safety Requirements.
- B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- C. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- D. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
- E. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
- F. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification.
- G. AWS D1.1/D1.1M - Structural Welding Code - Steel.
- H. AWS D1.2/D1.2M - Structural Welding Code - Aluminum.
- I. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel AC172.
- J. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer.

1.03 SUBMITTALS

- A. Shop Drawings:
 - 1. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 - 2. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
- B. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.
- C. Fabricator's Qualification Statement: Provide documentation showing steel fabricator is accredited under IAS AC172.

1.04 QUALITY ASSURANCE

- A. Design ladder under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the Commonwealth of Pennsylvania.
- B. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and AWS D1.2/D1.2M and dated no more than 12 months before start of scheduled welding work.

PART 2 PRODUCTS**2.01 MATERIALS - STEEL**

- A. Steel Sections: ASTM A36/A36M.
- B. Plates: ASTM A283/A283M.
- C. Mechanical Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.
- D. Bolts, Nuts, and Washers: ASTM A307, plain.
- E. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

- F. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- D. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.03 FABRICATED LADDERS

- A. Ladders: Steel; in compliance with ANSI A14.3; with mounting brackets and attachments; prime paint finish.
 - 1. Side Rails: 3/8 by 2 inches members spaced at 20 inches.
 - 2. Rungs: One inch diameter solid round bar spaced 12 inches on center.
 - 3. Space rungs 7 inches from wall surface.

2.04 FINISHES - STEEL

- A. Prime paint steel items.
 - 1. Do not prime surfaces where field welding is required.
- B. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- C. Prime Painting: Two coats.

2.05 FABRICATION TOLERANCES

- A. Squareness: 1/8 inch maximum difference in diagonal measurements.
- B. Maximum Offset Between Faces: 1/16 inch.
- C. Maximum Misalignment of Adjacent Members: 1/16 inch.
- D. Maximum Bow: 1/8 inch in 48 inches.
- E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Supply setting templates to the appropriate entities for steel items required to be embedded in masonry.

3.03 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Perform field welding in accordance with AWS D1.1/D1.1M.
- D. Obtain approval prior to site cutting or making adjustments not scheduled.
- E. After erection, prime welds, abrasions, and surfaces not shop primed .

3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.

- C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION

**SECTION 06 10 00
ROUGH CARPENTRY****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Preservative treated wood materials.
- B. Fire retardant treated wood materials.
- C. Communications and electrical room mounting boards.
- D. Concealed wood blocking, nailers, and supports.

1.02 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- C. AWPA U1 - Use Category System: User Specification for Treated Wood.
- D. PS 1 - Structural Plywood.
- E. PS 20 - American Softwood Lumber Standard.
- F. SPIB (GR) - Grading Rules.

1.03 SUBMITTALS

- A. Product Data: Provide technical data on wood preservative materials.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.
- B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, and installation.

PART 2 PRODUCTS**2.01 GENERAL REQUIREMENTS**

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. Species: Southern Pine, unless otherwise indicated.
 - 2. If no species is specified, provide species graded by the agency specified; if no grading agency is specified, provide lumber graded by grading agency meeting the specified requirements.
 - 3. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee at www.alsc.org, and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Grading Agency: Southern Pine Inspection Bureau, Inc; SPIB (GR).
- B. Sizes: Nominal sizes as indicated on drawings, S4S.
- C. Moisture Content: S-dry or MC19.
- D. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
 - 1. Lumber: S4S, No. 2 or Standard Grade.
 - 2. Boards: Standard or No. 3.

2.03 CONSTRUCTION PANELS

- A. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood, or medium density fiberboard; 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.

2.04 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. Metal and Finish: Hot-dipped galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.

2.05 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWWA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
 - 1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
 - 2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWWA standards.
- B. Fire Retardant Treatment:
 - 1. Interior Type A: AWWA U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Treat rough carpentry items as indicated .
 - c. Do not use treated wood in applications exposed to weather or where the wood may become wet.
- C. Preservative Treatment:
 - 1. Preservative Pressure Treatment of Lumber Above Grade: AWWA U1, Use Category UC3B, Commodity Specification A using waterborne preservative.
 - a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 - b. Treat lumber exposed to weather.
 - c. Treat lumber in contact with roofing, flashing, or waterproofing.
 - d. Treat lumber in contact with masonry or concrete.
 - 2. Preservative Pressure Treatment of Plywood Above Grade: AWWA U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative.
 - a. Kiln dry plywood after treatment to maximum moisture content of 19 percent.
 - b. Treat plywood in contact with masonry or concrete.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.
- B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
- C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.02 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- B. In framed assemblies that have concealed spaces, provide solid wood fireblocking as required by applicable local code, to close concealed draft openings between floors and between top story and roof/attic space; other material acceptable to authorities having jurisdiction may be used in lieu of solid wood blocking.

- C. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.
- D. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
- E. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.
- F. Provide the following specific nonstructural framing and blocking:
 - 1. Cabinets and shelf supports.
 - 2. Wall brackets.
 - 3. Grab bars.
 - 4. Towel and bath accessories.
 - 5. Wall-mounted door stops.
 - 6. Television brackets.
 - 7. Other detailed locations.

3.03 INSTALLATION OF CONSTRUCTION PANELS

- A. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches on center on all edges and into studs in field of board.
 - 1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
 - 2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
 - 3. Install adjacent boards without gaps.

3.04 CLEANING

- A. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill.
- B. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION

**SECTION 07 14 00
FLUID-APPLIED WATERPROOFING**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Water-based asphalt emulsion waterproofing.

1.02 REFERENCE STANDARDS

- A. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension.
- B. ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
- C. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- D. NRCA (WM) - The NRCA Waterproofing Manual.

1.03 SUBMITTALS

- A. Product Data: Provide data for membrane, flexible flashings, joint cover sheet, and joint and crack sealants.
- B. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.
- C. Manufacturer's qualification statement.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.

PART 2 PRODUCTS**2.01 FLUID-APPLIED WATERPROOFING MATERIALS**

- A. Water-Based Asphalt Emulsion Waterproofing:
 - 1. Cured Thickness: 60 mil, 0.060 inch, minimum.
 - 2. Suitable for installation over exterior sheathing board substrates.
 - 3. Elongation: 1,000 percent, minimum, measured in accordance with ASTM D412.
 - 4. Water Vapor Permeability: 0.02 perm, maximum, measured in accordance with ASTM E96/E96M.
 - 5. Adhesion: 150 psi, minimum, measured in accordance with ASTM D4541.
 - 6. Products:
 - a. Carlisle Coatings & Waterproofing, Inc; Barriseal-S: www.carlisleccw.com/#sle.
 - b. Mar-flex Waterproofing & Building Products: www.mar-flex.com/#sle.
 - c. NaturaSeal; SpraySeal NS-F300-BG: www.naturaseal.com/#sle.
 - d. Tremco Commercial Sealants & Waterproofing; TREMproof 260: www.tremcosealants.com/#sle.
 - e. W. R. Meadows, Inc; MEL-ROL LM: www.wrmeadows.com/#sle.
 - f. Or approved equal.
- B. Flexible Flashings: Type recommended by membrane manufacturer.
- C. Joint Cover Sheet: 1 inch minimum thickness, elastic sheet material designated for and compatible with membrane.

2.02 ACCESSORIES

- A. Sealant for Joints and Cracks in Substrate: Type compatible with waterproofing material and as recommended by waterproofing manufacturer.
- B. Counterflashings: See Section 07 62 00.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify existing conditions before starting work.
- B. Verify substrate surfaces are free of frozen matter, dampness, loose particles, cracks, pits, projections, penetrations, or foreign matter detrimental to adhesion or application of waterproofing system.
- C. Verify that substrate surfaces are smooth, free of honeycomb or pitting, and not detrimental to full contact bond of waterproofing materials.
- D. Verify that items penetrating surfaces to receive waterproofing are securely installed.
- E. Do not proceed with this work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protect adjacent surfaces from damage not designated to receive waterproofing.
- B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions.
- C. Fill non-moving joints and cracks with a filler compatible with waterproofing materials.
- D. Seal moving cracks with sealant and non-rigid filler, using procedures recommended by sealant and waterproofing manufacturers.
- E. Prepare building expansion joints at locations as indicated on drawings.

3.03 INSTALLATION

- A. Install waterproofing to specified minimum thickness in accordance with manufacturers instructions and NRCA (WM) applicable requirements.
- B. Apply primer or surface conditioner at a rate recommended by manufacturer, and protect conditioner from rain or frost until dry.
- C. At joints and cracks less than 1/2 inch in width including joints between horizontal and vertical surfaces, apply 12 inch wide strip of joint cover sheet.
- D. At joints from 1/2 inch to 1 inch in width, loop joint cover sheet down into joint between 1-1/4 inch to 1-3/4 inch, and extend sheet at least 6 inches on either side of expansion joint.
- E. Center joint cover sheet over joints, roll sheet into 1/8 inch thick coating of waterproofing material and apply second coat over sheet extending at least 6 inches beyond sheet edges.
- F. Apply extra thickness of waterproofing material at corners, intersections, and angles.
- G. Seal membrane and flashings to adjoining surfaces.

3.04 PROTECTION

- A. Do not permit traffic over unprotected or uncovered membrane.

END OF SECTION

**SECTION 07 21 00
THERMAL INSULATION**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Batt insulation in exterior wall construction.
- B. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.

1.02 RELATED REQUIREMENTS

- A. Section 07 54 00 - Thermoplastic Membrane Roofing: Installation requirements for board insulation over metal roof deck.

1.03 REFERENCE STANDARDS

- A. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- C. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C.

1.04 SUBMITTALS

- A. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
- B. Shop Drawings: Submit drawings that indicate location of joint or termination detail conditions.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.05 FIELD CONDITIONS

- A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

PART 2 PRODUCTS**2.01 APPLICATIONS**

- A. Insulation in Metal Framed Walls: Batt insulation with no vapor retarder.
- B. Insulation over Roof Deck: As specified in Section 07 54 00.

2.02 FOAM BOARD INSULATION MATERIALS

- A. Board insulation over metal roof deck, see Section 07 54 00.

2.03 MINERAL FIBER BLANKET INSULATION MATERIALS

- A. Flexible Glass Fiber Blanket Thermal Insulation: Preformed insulation, complying with ASTM C665; friction fit.
 - 1. Flame Spread Index: 75 or less, when tested in accordance with ASTM E84.
 - 2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
 - 3. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
 - 4. Facing: Aluminum foil, flame spread 25 rated; one side.

2.04 ACCESSORIES

- A. Nails or Staples: Steel wire; electroplated or galvanized; type and size to suit application.
- B. Wire Mesh: Galvanized steel, hexagonal wire mesh.
- C. Protection Board for Below Grade Insulation: Cementitious, 1/4 inch thick.
- D. Adhesive: Type recommended by insulation manufacturer for application.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.
- B. Verify substrate surfaces are flat, free of irregularities or materials or substances that may impede adhesive bond.

3.02 INSULATED CONCRETE AT FOUNDATION PERIMETER

- A. Place protective boards over exposed foundation insulation surfaces.
 - 1. Apply adhesive in five continuous beads per board length.
 - 2. Install boards horizontally from base of foundation to top of insulation.
 - 3. Butt boards tightly, with joints staggered from insulation joints.

3.03 BOARD INSTALLATION OVER ROOF DECK

- A. Installation of board insulation over metal roof deck, see Section 07 54 00.

3.04 BATT INSTALLATION

- A. Install insulation and vapor retarder in accordance with manufacturer's instructions.
- B. Install in exterior wall and roof spaces without gaps or voids. Do not compress insulation.
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
- E. Install with factory-applied vapor retarder membrane facing warm side of building spaces. Lap ends and side flanges of membrane over framing members.
- F. Tape insulation batts in place.
- G. Tape seal butt ends, lapped flanges, and tears or cuts in membrane.
- H. At metal framing, place vapor retarder on warm side of insulation; lap and seal sheet retarder joints over face of member
- I. Tape seal tears or cuts in vapor retarder.
- J. Extend vapor retarder tightly to full perimeter of adjacent window and door frames and other items interrupting the plane of the membrane; tape seal in place.

3.05 PROTECTION

- A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION

**SECTION 07 41 13
METAL ROOF PANELS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Metal roof panel system of preformed steel panels.

1.02 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).
- B. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- D. ASTM E1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
- E. ASTM E1646 - Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference.
- F. ASTM E1680 - Standard Test Method for Rate of Air Leakage through Exterior Metal Roof Panel Systems.
- G. UL 580 - Standard for Tests for Uplift Resistance of Roof Assemblies.

1.03 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Storage and handling requirements and recommendations.
 - 2. Installation methods.
 - 3. Specimen warranty.
- B. Shop Drawings: Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayments, and special conditions.
 - 1. Show work to be field-fabricated or field-assembled.
- C. Selection Samples: For each roofing system specified, submit color chips representing manufacturer's full range of available colors and patterns.
- D. Test Reports: Indicate compliance of metal roofing system to specified requirements.
- E. Warranty: Submit specified manufacturer's warranty and ensure that forms have been completed in Government's name and are registered with manufacturer.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section and with at least three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store roofing panels on project site as recommended by manufacturer to minimize damage to panels prior to installation.

1.06 FIELD CONDITIONS

- A. Do not install metal roof panels, eave protection membrane or underlayment when surface, ambient air, or wind chill temperatures are below 45 degrees F.

1.07 WARRANTY

- A. Finish Warranty: Provide 5-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Government's name and register with warrantor.
- B. Special Warranty: Provide 5-year warranty for weathertightness of roofing system, including agreement to repair or replace metal roof panels that fail to keep out water commencing on the Date of Substantial Completion. Complete forms in Government's name and register with warrantor.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Architectural Metal Roof Panel Manufacturers:
 - 1. ATAS International, Inc: www.atas.com/#sle.
 - 2. Berridge Manufacturing Company: www.berridge.com/#sle.
 - 3. Drexel Metals Inc: www.drexmet.com/#sle.
 - 4. Englert, Inc: www.englertinc.com/#sle.
 - 5. Fabral: www.fabral.com/#sle.
 - 6. Metal Roofing Systems, Inc: www.metalroofingsystems.biz/#sle.
 - 7. Metl-Span, a Nucor Company: www.metlspan.com/#sle.
 - 8. Petersen Aluminum Corporation; Snap-Clad Panel: www.pac-clad.com/#sle.
 - 9. Or approved equal.
- B. Metal Soffit Panels Manufacturers:
 - 1. ATAS International, Inc: www.atas.com/#sle.
 - 2. Berridge Manufacturing Company: www.berridge.com/#sle.
 - 3. Englert, Inc: www.englertinc.com/#sle.
 - 4. Fabral: www.fabral.com/#sle.
 - 5. McElroy Metal: www.mcelroymetal.com/#sle.
 - 6. Metal Roofing Systems, Inc: www.metalroofingsystems.biz/#sle.
 - 7. Petersen Aluminum Corporation; Flush Soffit: www.pac-clad.com/#sle.
 - 8. Or approved equal.

2.02 PERFORMANCE REQUIREMENTS

- A. Metal Roof Panels: Provide complete roofing assemblies, including roof panels, clips, fasteners, connectors, and miscellaneous accessories, tested for compliance with the following minimum standards:
 - 1. Structural Design Criteria: Provide panel assemblies designed to safely support design loads at support spacing indicated, with deflection not to exceed L/180 of span length(L) when tested in accordance with ASTM E1592.
 - a. Dead Loads: Weight of roofing system.
 - b. Live Loads: As required by ASCE 7.
 - 2. Overall: Complete weathertight system tested and approved in accordance with ASTM E1592.
 - 3. Wind Uplift: Class 90 wind uplift resistance of UL 580.
 - 4. Air Infiltration: Maximum 0.06 cfm/sq ft at air pressure differential of 6.24 lbf/sq ft, when tested according to ASTM E1680.
 - 5. Water Penetration: No water penetration when tested in accordance with procedures and recommended test pressures of ASTM E1646; perform test immediately following air infiltration test.
 - 6. Thermal Movement: Design system to accommodate without deformation anticipated thermal movement over ambient temperature range of 100 degrees F.

2.03 METAL ROOF PANELS

- A. Metal Roof Panels: Provide complete engineered system complying with specified requirements and capable of remaining weathertight while withstanding anticipated movement of substrate and thermally induced movement of roofing system.
- B. Metal Panels: Factory-formed panels with factory-applied finish.
 - 1. Steel Panels:
 - a. Zinc-coated steel complying with ASTM A653/A653M; minimum G60 galvanizing.
 - b. Steel Thickness: Minimum 24 gauge, 0.024 inch.
 - 2. Profile: Standing seam, with minimum 1-1/2-inch seam height; concealed fastener system lapped seam in standing seam profile.
 - 3. Texture: Smooth.
 - 4. Length: Maximum possible length to minimize lapped joints. Where lapped joints are unavoidable, space laps so that each sheet spans over three or more supports.
 - 5. Width: Maximum panel coverage of 24 inches.

2.04 ATTACHMENT SYSTEM

- A. Concealed System: Provide manufacturer's standard stainless steel or nylon-coated aluminum concealed anchor clips designed for specific roofing system and engineered to meet performance requirements, including anticipated thermal movement.

2.05 FABRICATION

- A. Panels: Provide factory or field fabricated panels with applied finish and accessory items, using manufacturer's standard processes as required to achieve specified appearance and performance requirements.
- B. Joints: Provide captive gaskets, sealants, or separator strips at panel joints to ensure weathertight seals, eliminate metal-to-metal contact, and minimize noise from panel movements.

2.06 FINISHES

- A. Fluoropolymer Coil Coating System: Manufacturer's standard multi-coat metal coil coating system complying with AAMA 2605, including at least 70 percent polyvinylidene fluoride (PVDF) resin, and at least 80 percent of coil coated metal surfaces having minimum total dry film thickness (DFT) of 0.9 mil, 0.0009 inch; color and gloss Interstate Blue by Drexel Metals.
- B. Solar Reflectance Index (SRI): 39, Initial, greater than 2:12 steep-sloped roof.

2.07 ACCESSORIES

- A. Miscellaneous Sheet Metal Items: Provide flashings, trim, moldings, closure strips, preformed crickets, caps, and equipment curbs of the same material, thickness, and finish as used for the roofing panels. Items completely concealed after installation may optionally be made of stainless steel.
- B. Rib and Ridge Closures: Provide prefabricated, close-fitting components of steel with corrosion resistant finish or combination steel and closed-cell foam.
- C. Sealants:
 - 1. Exposed Sealant: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane.
 - 2. Concealed Sealant: Non-curing butyl sealant or tape sealant.
 - 3. Seam Sealant: Factory-applied, non-skinning, non-drying type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation of preformed metal roof panels until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Contracting Officer or Contracting Officer's Representative of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Coordinate roofing work with provisions for roof drainage, flashing, trim, penetrations, and other adjoining work to ensure that completed roof will be free of leaks.
- B. Remove protective film from surface of roof panels immediately prior to installation; strip film carefully to avoid damage to prefinished surfaces.
- C. Separate dissimilar metals by applying a bituminous coating, self-adhering rubberized asphalt sheet, or other permanent method approved by metal roof panel manufacturer.
- D. Protect surrounding areas and adjacent surfaces from damage during execution of this work.
- E. At locations where metal will be in contact with wood or other absorbent material subject to wetting, seal joints with sealing compound and apply one coat of heavy-bodied bituminous paint.

3.03 INSTALLATION

- A. Overall: Install roofing system in accordance with approved shop drawings and metal roof panel manufacturer's instructions and recommendations, as applicable to specific project conditions; securely anchor components of roofing system in place allowing for thermal and structural movement.
 - 1. Install roofing system with concealed clips and fasteners, except as otherwise recommended by manufacturer for specific circumstances.
 - 2. Minimize field cutting of panels. Where field cutting is required, use methods that will not distort panel profiles. Use of torches for field cutting is prohibited.
- B. Accessories: Install necessary components that are required for complete roofing assembly, including flashings, gutters, downspouts, trim, closure strips, caps, equipment curbs, rib closures, ridge closures, and similar roof accessory items.
- C. Roof Panels: Install metal roof panels in accordance with manufacturer's installation instructions, minimizing transverse joints except at junction with penetrations.
 - 1. Provide concealed clips at panel joints, and apply snap-on battens to provide weathertight joints.
 - 2. Provide sealant tape or other approved joint sealer at lapped panel joints.
 - 3. Install sealant or sealant tape at end laps and side joints as recommended by metal roof panel manufacturer.

3.04 CLEANING

- A. Clean exposed sheet metal work at completion of installation. Remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving the work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to the finish.

3.05 PROTECTION

- A. Do not permit storage of materials or roof traffic on installed roof panels. Provide temporary walkways or planks as necessary to avoid damage to completed work. Protect roofing until completion of project.
- B. Touch-up, repair, or replace damaged roof panels or accessories before Date of Substantial Completion.

END OF SECTION

**SECTION 07 42 13.00
METAL WALL PANELS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Exterior wall panels.

1.02 REFERENCE STANDARDS

- A. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
- B. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components.

1.03 SUBMITTALS

- A. Product Data - Wall System: Manufacturer's data sheets on each product used, including:
 - 1. Physical characteristics of components shown on shop drawings.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation instructions and recommendations.
- B. Shop Drawings: Indicate dimensions, layout, joints, construction details, support clips, and anchorage methods.
- C. Samples: Submit two samples of wall panel and soffit panel, 3 by 3 inches in size illustrating finish color, sheen, and texture.
- D. Test Reports: Submit test report verifying compliance with NFPA 285 for previously tested exterior wall assembly.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years of documented experience.
- B. Installer Qualifications: Company specializing in installing products specified in this section with minimum five years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
- B. Store prefinished material off the ground and protected from weather; prevent twisting, bending, or abrasion; provide ventilation; slope metal sheets to ensure proper drainage.
- C. Prevent contact with materials that may cause discoloration or staining of products.

1.06 FIELD CONDITIONS

- A. Do not install wall panels when air temperature or relative humidity is outside manufacturer's limits.

PART 2 PRODUCTS**2.01 MANUFACTURER**

- A. Metal Wall Panels - Concealed Fasteners:
 - 1. Petersen Aluminum Corporation; Flush Wall Panels: www.pac-clad.com/#sle.
 - 2. Or approved equal.

2.02 METAL WALL PANEL SYSTEM

- A. Wall Panel System: Factory-fabricated, prefinished metal panel system, site assembled.
 - 1. Provide exterior wall panels and soffit panels.

2. Provide components which will support panel dead loads and withstand live loads caused by positive and negative wind pressure acting normally to plane of wall.
 3. Fire Performance: Tested in accordance with and complying with acceptance criteria of NFPA 285.
 4. Movement: Accommodate movement within system without damage to components or deterioration of seals; between system and perimeter components when subject to seasonal temperature cycling; when subject to dynamic loading and release of loads; and under deflection of structural support framing.
 5. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
 6. Fabrication: Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.
- B. Exterior Wall Panels:
1. Profile: Vertical; flush style.
 2. Side Seams: Double-interlocked, tight-fitting, sealed with continuous gaskets.
 3. Material: Precoated steel sheet, 22 gauge, 0.0299-inch minimum thickness.
 4. Panel Width: 12 inches.
 5. Color: As selected by Contracting Officer or Contracting Officer's Representative from manufacturer's standard line.
- C. Internal and External Corners: Same material, thickness, and finish as exterior sheets; profile to suit system; shop cut and factory mitered to required angles.
1. Provide mitered internal corners, back braced with 22 gauge, 0.0759 inch thick, precoated metal sheet to maintain continuity of profile.
- D. Expansion Joints: Same material, thickness, and finish as exterior sheets; 22 gauge, 0.0759 inch thick; manufacturer's standard brake-formed type, of profile to suit system.
- E. Trim: Same material, thickness, and finish as exterior sheets; brake-formed to required profiles.
- F. Anchors: Galvanized steel.

2.03 MATERIALS

- A. Precoated Steel Sheet: Aluminum-zinc alloy-coated steel sheet, ASTM A792/A792M, Commercial Steel (CS) or Forming Steel (FS), with AZ50/AZM150 coating; continuous coil-coated on exposed surfaces and panel back with specified finishes.
- B. Select materials with surface flatness, smoothness, and lack of surface blemishes where exposed to view in finished system.

2.04 FINISHES

- A. Exposed Surface Finish: Panel manufacturer's standard polyvinylidene fluoride (PVDF) coating, top coat over epoxy primer.
- B. Panel Backside Finish: Panel manufacturer's standard siliconized polyester wash coat.

2.05 ACCESSORIES

- A. Panel Support System:
1. Galvanized steel hat channels, 1/2" thick.
- B. Gaskets: Manufacturer's standard type suitable for use with system, permanently resilient; ultraviolet and ozone resistant.
- C. Exposed Sealant: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane; see Section 07 9200.
- D. Fasteners: Manufacturer's standard type to suit application; with soft neoprene washers, steel, hot-dip galvanized. Fastener cap same color as exterior panel.
- E. Field Touch-Up Paint: As recommended by panel manufacturer.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that building framing members are ready to receive panels.

3.02 PREPARATION

- A. Install hat channels perpendicular to panel length, securely fastened to substrates and shimmed and leveled to uniform plane, and spaced at 24 inches on center, maximum.
- B. Protection of In-Place Conditions: Protect surrounding areas and adjacent surfaces from damage during execution of this work.

3.03 INSTALLATION

- A. Install panels on walls in accordance with manufacturer's instructions.
- B. Protect surfaces in contact with cementitious materials and dissimilar metals with bituminous paint; allow to dry prior to wall panel installation.
- C. Lap panel ends 2 inches, minimum.
- D. Use concealed fasteners unless otherwise indicated by Contracting Officer or Contracting Officer's Representative.
- E. Seal and place gaskets to prevent weather penetration. Maintain neat appearance.

3.04 TOLERANCES

- A. Offset from True Alignment between Adjacent Members Abutting or In Line: 1/16 inch, maximum.
- B. Variation from Plane or Location as Indicated on Drawings: 1/4 inch, maximum.

3.05 CLEANING

- A. Remove site cuttings from finish surfaces.
- B. Remove protective material from wall panel surfaces.
- C. Clean and wash prefinished surfaces with mild soap and water; rinse with clean water.

3.06 PROTECTION

- A. Protect metal wall panels until completion of project.
- B. Touch up, repair, or replace damaged wall panels or accessories before Date of Substantial Completion.

END OF SECTION

**SECTION 07 42 13.19
INSULATED METAL WALL PANELS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Factory-assembled metal panel system for walls, with trim, related flashings and accessory components.

1.02 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- C. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- E. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- F. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.

1.03 SUBMITTALS

- A. Product Data: Provide manufacturer documentation on tested structural, thermal, and fire resistance capabilities of assembled panel.
- B. Shop Drawings: Indicate dimensions.
- C. Samples: Submit two samples of panel, 4x4 inch in size illustrating finish color, sheen, and texture.
- D. Design and Performance Data: Indicate panel profile and dimensions.
- E. Manufacturer's qualification statement.
- F. Warranty Documentation for Installation of Building Rainscreen Assembly: Submit installer warranty and ensure that forms have been completed in Government's name and registered with installer.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in performing work of this Section with minimum three years experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
- B. Store pre-finished material off ground with weather protection to prevent twisting, bending, or abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- C. Prevent contact with materials that could cause discoloration or staining.

1.06 FIELD CONDITIONS

- A. Do not install panels when air temperature or relative humidity are outside manufacturer's limits.

1.07 WARRANTY

- A. Finish Warranty: Provide 5-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Government's name and register with warrantor.

- B. Special Warranty: Provide 2-year warranty covering water tightness and integrity of seals of metal plate wall panels. Complete forms in Government's name and register with warrantor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Insulated Metal Wall Panels:
1. Centria, a Nucor Company; TotalClad: www.centria.com/#sle.
 2. Kingspan Insulated Panels; KS Series Wall Panel, with Profile Fluted: www.kingspan.com/#sle.
 3. Metl-Span, a Nucor Company; CF Flute: www.metlspan.com/#sle.
 4. MBCI, a Cornerstone Building Brands Company: www.mbc.com/#sle.
 5. Or approved equal.

2.02 PERFORMANCE / DESIGN CRITERIA

- A. Metal Panel System: Factory-assembled metal panel system, with trim, related flashings and accessory components.
1. Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
 2. Accommodate tolerances of building structural framing.
- B. Performance Requirements:
1. Thermal Performance: Provide thermal resistance through entire system; R-value of 26, minimum.
 2. Structural Performance: Design and size to withstand all dead loads and wind loads caused by positive and negative wind pressure acting normal to plane of panel.
 - a. Verify structural performance in accordance with ASTM E330/E330M, using test pressure 1.5 times design wind pressure, with 10 seconds duration of maximum load.
 3. Movement: Accommodate the movement caused by the following without damage to system, components, or deterioration of seals:
 - a. Normal movement between system components.
 - b. Seasonal temperature cycling.
 - c. Deflection of structural support framing,

2.03 COMPONENTS

- A. Wall Panels: Exterior and interior metal sheet skin, factory-assembled, with foamed-in-place insulation; exterior and interior sheet interlocking at edges, fitted with continuous gaskets.
1. Panel Width: 42 inch.
 2. Profile: Grooved; vertical panels.
 3. Panel Thickness: 3 inch.
 4. Exterior Sheet: Pre-finished galvanized steel, 22 gauge, 0.0299 inch minimum base metal thickness; stucco embossed.
 5. Interior Sheet: Galvanized steel, pre-finished, 22 gauge, 0.0299 inch minimum base metal thickness.
 6. Panel Edge Profile: Tongue and groove, for flush seam.
 7. Fabricate panels in longest practicable lengths.
 8. Exterior Finish: Polyvinylidene fluoride (PVDF) coating; color as selected from manufacturer's standard range.
 9. Interior Finish: Polyvinylidene fluoride (PVDF) coating; white color.
- B. Internal and External Corners: Same material, thickness, and finish as exterior sheets; factory-fabricated mitered to required angles in one continuous piece with minimum 6 inch returns.
- C. Trim, Closure Pieces, Expansion Joints, Flashings, and Infills: Same material, thickness and finish as exterior sheets; factory-fabricated to required profiles; fabricated in longest practicable lengths.
1. Exposed Fasteners: Not permitted.
 2. Profiles: To suit system.

2.04 MATERIALS

- A. Precoated Galvanized Steel Sheet: ASTM A653/A653M, Commercial Steel (CS) or Forming Steel (FS), with G90/Z275 coating; continuous-coil-coated with acrylic primer coat, silicone polyester top coat, and polyester washcoat for panel back.
 - 1. Color of Exposed Exterior Surfaces: As selected by Contracting Officer or Contracting Officer's Representative from manufacturer's standard range.
- B. Foamed-in-Place Insulation: Urethane type.
 - 1. Thermal Conductivity (k factor): 0.16 in accordance with ASTM C177 test method.
 - 2. Water Vapor Transmission: 0 perms, in accordance with ASTM E96/E96M test method.
 - 3. Water Vapor Absorption: 0 percent by volume, maximum, in accordance with ASTM D2842 test method.
 - 4. Surface Burning Characteristics: Flame spread/smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.
- C. Gaskets: Manufacturer's standard type suitable for use with panel system, permanently resilient; ultraviolet and ozone resistant; color as selected by Architect.
- D. Panel Sealants: Manufacturer's standard type suitable for use with installation of panel system; non-staining, skinning, non-shrinking, non-sagging, ultra-violet and ozone resistant; color as selected by Architect.

2.05 ACCESSORIES

- A. Support for Cladding and Continuous Insulation: Thermal clips.
 - 1. Thermally-broken clips that provide attachment support for girts, angles, channels, and other cladding support framing.
 - 2. Galvanized Steel Support Clip: 14 gauge, 0.0747 inch, G90/Z275 galvanized support clip complying with ASTM A653/A653M, with integral glass fiber reinforced polyamide thermal isolator pad.
 - 3. Clip Depth: As required for thickness of insulation.
 - 4. Spacing of Clips: 16 inches on center, vertically.
 - 5. Fasteners: As recommended by clip manufacturer.
- B. Concealed Sealants: Non-curing butyl sealant or tape sealant.
- C. Exposed Sealants: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane.
- D. Fasteners: Manufacturer's standard type to suit application; hot-dip galvanized steel with soft neoprene washers; provide with fastener cap same color as exterior panel.
- E. Field Touch-up Paint: As recommended by panel manufacturer.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that structural framing is ready to receive panel system.

3.02 PREPARATION

- A. Protect surrounding areas and adjacent surfaces from damage during execution of this work.

3.03 INSTALLATION

- A. Install panel system on walls in accordance with manufacturer's instructions.
- B. Protect panel surfaces in contact with cementitious materials with bituminous paint; allow paint to dry prior to installation.
- C. Permanently fasten panel system to structural supports; aligned, level, and plumb, within specified tolerances.
- D. Locate panel joints over supports.

- E. Use concealed fasteners unless otherwise approved by Contracting Officer or Contracting Officer's Representative.
- F. Seal and place gaskets to prevent weather penetration. Maintain neat appearance.

3.04 TOLERANCES

- A. Maximum Offset From True Alignment Between Adjacent Members Butting or In Line: 1/16 inch.
- B. Maximum Variation from Plane or Location Indicated on Drawings: 1/4 inch.

3.05 CLEANING

- A. Remove site cuttings from finish surfaces.
- B. Clean and wash prefinished surfaces with mild soap and water; rinse with clean water.

3.06 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION

SECTION 07 42 13.23
METAL COMPOSITE MATERIAL WALL PANELS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Metal composite material wall panel system.

1.02 ABBREVIATIONS AND ACRONYMS

- A. MCM: Metal Composite Material.

1.03 REFERENCE STANDARDS

- A. AAMA 508 - Voluntary Test Method and Specification for Pressure Equalized Rainscreen Wall Cladding Systems.
- B. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).
- C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
- D. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- E. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- F. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- G. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- H. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes.
- I. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
- J. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- K. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- L. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- M. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
- N. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
- O. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- P. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- Q. ASTM E1233/E1233M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Cyclic Air Pressure Differential.

1.04 SUBMITTALS

- A. Product Data:
 - 1. Wall System: Manufacturer's data sheets on each product.
 - 2. MCM Panels: Manufacturer's data sheets on each product.
- B. Shop Drawings: Indicate layout, elevations, dimensions of panels, connections, details and location of joints, sealants, gaskets, method of anchorage, support clips, anchors, supports, reinforcement, trim, flashings, and accessories.
 - 1. Indicate panel numbering system.

2. Differentiate between shop and field fabrication.
 3. Indicate adjustments required to coordinate with adjacent work within wall system.
 4. Include large scale details of anchorages and connecting elements.
 5. Include details or schematic, exploded, or isometric diagrams to explain flashing at scale of minimum 1-1/2 inches equals 12 inches (1:10).
- C. Samples:
1. For Initial Selection: For each finish product, including sealants, provide three color chips representing manufacturer's standard range of available colors and patterns.
- D. Test Reports: Submit report of full-size mock-up tests for air infiltration, water penetration, and wind performance.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of type specified and with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original, unopened, and undamaged containers with identification labels intact.
- B. Storage:
1. Store products protected from exposure to harmful weather conditions and at temperatures recommended by manufacturer.
 2. Store in well-ventilated space out of direct sunlight.
 3. Protect from moisture and condensation with weathertight covering installed to provide ventilation.
 4. Store at slope, ensuring positive drainage of accumulated water.

1.07 FIELD CONDITIONS

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ALUCOBOND by 3A Composites USA; ALUCOBOND PLUS - EasyFix:
www.alucobondusa.com/#sle.
- B. Alcotex, Inc.
- C. ALPOLIC Materials.
- D. Fairview Architectural LLC.
- E. Or approved equal.

2.02 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Comply with ASTM E330/E330M.
1. Size components to support assembly dead loads and withstand live loads caused by positive and negative wind pressure acting normally to wall plane.
 2. Design Wind Loads: Comply with ASCE 7.
 3. Maximum Allowable Deflection:
 - a. Panels: L/60 for length (L) of span.
 - b. Perimeter Framing: L/175 normal to plane of wall.
 - c. Anchors: 1/16 inch at connection points to framing members.
 4. Panel Bow: Maximum 0.8 percent of panel width and length.
- B. Uniform Static Air Pressure: Comply with ASTM E330/E330M.

1. Positive Wind Load: Net deflection of minus 0.307 inch when tested at pressure of 75 psf.
2. Negative Wind Load: Net deflection of 0.334 inch when tested at pressure of 75 psf.
- C. Thermal Movement: Provide system accommodating expansion and contraction from thermal movement at material temperature range of minus 20 degrees F to 180 degrees F without noise, buckling, or damage to system components.
- D. Cyclic Air Pressure: Able to withstand maximum external gust pressure of 25.1 psf and maximum cavity pressure of 15.3 psf for 0.08 seconds when tested in accordance with ASTM E1233/E1233M.
- E. Surface Burning Characteristics: Flame spread index of 25, maximum, and smoke developed index of 450, maximum, when tested in accordance with ASTM E84.
- F. Building Envelope Performance: Comply with ASHRAE Std 90.1 I-P when tested as part of building envelope assembly.

2.03 METAL COMPOSITE MATERIAL WALL PANEL SYSTEM

- A. Description: Rainscreen type; metal panels, fasteners, and anchors designed for use with supports provided by others.
- B. Provide watertight and structurally sound wall panel system that prevents uncontrolled water penetration on inside face of system.
- C. MCM Panels: Comprised of two 0.020-inch thick aluminum sheet facings bonded to extruded thermoplastic core.
 1. Thickness: 0.157 inch.
 2. Core: Fire retardant.
 3. Exterior Finish: PVDF fluoropolymer.
 4. Provide manufacturer's standard stiffeners to maintain panel flatness without showing local stresses or read-through on panel face.
 5. Provide concealed attachment to supporting structure with attachment members adhered to back of panel.
- D. Steel Framing Members: Include sub-girts, zee-clips, base and sill angles and channels, hat-shaped and rigid channels, and furring channels required for complete installation.
 1. Provide material strength, dimensions, and configuration as required by structural engineer to meet applied loads and in accordance with applicable building code.
- E. Drainage Holes: AAMA 508, 3/8-inch diameter, 16 inches on center.

2.04 MATERIALS

- A. Aluminum Sheet: ASTM B209/B209M, 6061 alloy, T6 temper.
- B. Aluminum Extrusions: ASTM B221 and ASTM B221M.

2.05 FABRICATION

- A. Fabricate panels as indicated on drawings and as recommended by MCM sheet manufacturer:
 1. Rout and return panel edges.
 2. Ensure panel lines, breaks, curves, and angles are sharp and true.
 3. Keep plane surfaces free from warp or buckle.
 4. Keep panel surfaces free of scratches or marks.

2.06 FINISHES

- A. Fluoropolymer Coil Coating System: Polyvinylidene fluoride (PVDF) multicoat superior performing organic coatings system complying with AAMA 2605, including minimum 70 percent PVDF resin, with minimum 80 percent of coil-coated metal surfaces having minimum total dry film thickness of 0.9 mil, 0.0009 inch; color and gloss as indicated on drawings.
- B. Touch-Up Materials: As recommended by coating manufacturer for field application.

2.07 ACCESSORIES

- A. Flashing: Sheet aluminum, minimum 18 gauge, 0.040 inch thick; finish matching MCM sheet.

- B. Anchors, Clips, and Accessories: Provide one of the following:
 - 1. Stainless Steel: Comply with ASTM A276/A276M, ASTM A480/A480M, or ASTM A666/A666M.
 - 2. Steel: Comply with ASTM A36/A36M; hot-dip zinc coated in accordance with ASTM A153/A153M.
 - 3. Steel: Comply with ASTM A36/A36M; hot-dip galvanized in accordance with ASTM A123/A123M, with coating thickness grade of 100.
- C. Fasteners:
 - 1. Screws: Self-drilling or self-tapping Type 410 stainless steel or zinc-alloy steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of metal wall panels.
 - 2. Bolts: Stainless steel.
 - 3. Fasteners for Flashing and Trim: High-strength aluminum or stainless steel blind fasteners.
- D. Joint Sealer: Provide silicone sealant of type approved by MCM sheet manufacturer and in accordance with ASTM C920.
 - 1. Color: Clear.
- E. Provide panel system manufacturer's and installer's standard corrosion-resistant accessories, including fasteners, clips, anchorage devices, and attachments.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine dimensions, tolerances, and interfaces with other work.
 - 1. Verify installation of air- or water-resistive barriers over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Verify acceptability of substrate conditions for MCM system installation in accordance with manufacturer's instructions.
- C. Verify installation of girts, angles, channels, studs, and other structural support members and anchorage to ensure installation within alignment tolerances as required by panel manufacturer.

3.02 PREPARATION

- A. Protect adjacent work areas and finish surfaces from damage during installation.

3.03 INSTALLATION

- A. Do not install defective products, including warped, bowed, dented, and broken members and members with damaged finishes.
- B. Install panel system in accordance with fabricator's instructions, manufacturer's instructions, and approved shop drawings.
- C. Secure attachment members to back face of panels in accordance with MCM sheet manufacturer's instructions.
- D. Do not form panels in field unless required by wall system manufacturer and approved by Contracting Officer or Contracting Officer's Representative; comply with MCM sheet manufacturer's instructions and recommendations for field forming.
- E. Separate dissimilar metals; use gasket fasteners, isolation shims, or isolation tape to prevent electrolytic action between metals.
- F. Install flashing as indicated on shop drawings. At flashing butt joints, provide lap strap under flashing and seal lapped surfaces with full bed of nonhardening sealant.
- G. Do not locate fasteners on panel face or panel perimeter.
- H. Track Support:

1. Attach MCM wall panels to tracks by interlocking panel edges with fabricator's standard T-clips.
2. Install support assembly at locations, spacings, and with fasteners recommended by manufacturer.
3. Provide fabricator's standard horizontal and vertical tracks for support and secondary drainage assembly; ensure drainage to exterior at horizontal joints through drain tube.

3.04 TOLERANCES

- A. Installation Tolerances:
 1. Shim and align MCM wall panel units on level and plumb within tolerance of 1/4 inch in 20 feet, noncumulative.
 2. Install panels within 1/8 inch offset of adjoining faces and of alignment of matching profiles.

3.05 REPAIR

- A. Touch up, repair, or replace damaged wall panels and accessories in manner indistinguishable from undamaged components.

3.06 CLEANING

- A. Ensure weep holes and drainage channels are unobstructed and free of dirt and sealants.
- B. Clean installed products in accordance with manufacturer's instructions.

3.07 PROTECTION

- A. Protect installed panel system from damage until Date of Substantial Completion.

END OF SECTION

**SECTION 07 46 46
FIBER-CEMENT SIDING**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Fiber-cement siding.

1.02 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- B. ASTM C1186 - Standard Specification for Flat Fiber Cement Sheets.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's data sheets on each product to be used, including:
 - 1. Manufacturer's requirements for related materials to be installed by others.
 - 2. Preparation instructions and recommendations.
 - 3. Storage and handling requirements and recommendations.
 - 4. Installation methods, including nail patterns.
- C. Shop Drawings: Indicate dimensions, layout, joints, construction details, support clips, and methods of anchorage.
- D. Installer's Qualification Statement.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified in this section with minimum three years of experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store products under waterproof cover and elevated above grade, on a flat surface.

1.06 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Correct defective work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS**2.01 FIBER-CEMENT SIDING**

- A. Panel Siding: Horizontally oriented panels made of cement and cellulose fiber formed under high pressure with integral surface texture, complying with ASTM C1186, Type A, Grade II; with machined edges, for nail attachment.
 - 1. Texture: Stucco patterned.
 - 2. Length (Height): 96 inches, nominal.
 - 3. Width: 48 inches.
 - 4. Thickness: 5/16 inch, nominal.
 - 5. Finish: Factory applied topcoat.
 - 6. Color: Light Mist by James Hardie.
 - 7. Products:
 - a. Allura, a division of Plycem USA, Inc: www.allurausa.com/#sle.
 - b. CertainTeed Corporation : www.certainteed.com.
 - c. James Hardie Building Products, Inc: www.jameshardie.com/#sle.
 - d. Nichiha USA, Inc: www.nichiha.com/#sle.
 - e. Or approved equal.

2.02 ACCESSORIES

- A. Cladding Support Clips: Thermally-broken, galvanized steel clips for support of cladding z-girts, angles, channels and other framing.
 - 1. Galvanized Steel Sheet: ASTM A653/A653M, with G90/Z275 galvanized coating.
- B. Furring Strips, Metal: Galvanized metal channels.
- C. Trim: Same material and texture as siding.
- D. Metal Trim: Extruded aluminum alloy 6063-T5 temper.
 - 1. Manufacturers:
 - a. Tamlyn
 - b. Schluter Systems
 - c. Or approved equal
 - 2. Finish: Clear anodized.
 - 3. Vertical Profile Trim:
 - a. Type: As indicated on drawings.
 - 4. Horizontal Profile Trim:
 - a. Type: As indicated on drawings.
 - 5. Termination Profile Trim:
 - a. Type: As indicated on drawings.
 - 6. Outside Corner Trim:
 - a. Type: As indicated on drawings.
 - 7. Inside Corner Trim:
 - a. Type: As indicated on drawings.
 - 8. Water Management Profile Trim:
 - a. Type: As indicated on drawings.
- E. Fasteners: Galvanized or corrosion resistant; length as required to penetrate, 1-1/4 inch, minimum.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Examine substrate, clean and repair as required to eliminate conditions that would be detrimental to proper installation.
- B. Do not begin until unacceptable conditions have been corrected.

3.02 PREPARATION

- A. Install Sheet Metal Flashing:
 - 1. Above door and window trim and casings.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions and recommendations.
 - 1. Read warranty and comply with terms necessary to maintain warranty coverage.
 - 2. Use trim details indicated on drawings.
 - 3. Touch up field cut edges before installing.
 - 4. Pre-drill nail holes if necessary to prevent breakage.
- B. Over Masonry and Concrete Walls: Install furring strips of adequate thickness to accept full length of nails and spaced at 16 inches on center; leave space at top and bottom open; top may be behind soffit; at bottom install insect screen over opening by wrapping a strip of screen over bottom ends of vertical furring strips.
- C. Allow space for thermal movement between both ends of siding panels that butt against trim; seal joint between panel and trim with specified sealant.
- D. Joints in Horizontal Siding: Avoid joints in lap siding except at corners; where joints are inevitable stagger joints between successive courses.

- E. Joints in Vertical Siding: Install Z-flashing in horizontal joints between successive courses of vertical siding.
- F. Do not install siding less than 6 inches from surface of ground nor closer than 1 inch to roofs, patios, porches, and other surfaces where water may collect.
- G. After installation, seal joints except lap joints of lap siding; seal around penetrations, and paint exposed cut edges.

3.04 PROTECTION

- A. Protect installed products until Date of Substantial Completion.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

**SECTION 07 54 00
THERMOPLASTIC MEMBRANE ROOFING**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Adhered system with thermoplastic roofing membrane.
- B. Insulation, flat and tapered.
- C. Vapor retarder.
- D. Flashings.

1.02 REFERENCE STANDARDS

- A. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
- B. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
- C. ASTM D6878/D6878M - Standard Specification for Thermoplastic Polyolefin-Based Sheet Roofing.
- D. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.
- E. NRCA (RM) - The NRCA Roofing Manual.
- F. NRCA (WM) - The NRCA Waterproofing Manual.

1.03 SUBMITTALS

- A. Shop Drawings: Submit drawings that indicate joint or termination detail conditions, conditions of interface with other materials, and paver layout.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- C. Manufacturer's Installation Instructions: Indicate membrane seaming precautions and perimeter conditions requiring special attention.
- D. Manufacturer's Field Reports: Indicate procedures followed, ambient temperatures, humidity, wind velocity during application, and supplementary instructions given.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.
- G. Specimen Warranty: For approval.
- H. Warranty Documentation:
 - 1. Submit manufacturer warranty and ensure that forms have been completed in Government's name and registered with manufacturer.
 - 2. Submit installer's written verification that installation complies with warranty conditions for waterproof membrane.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of this section with at least three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original containers, dry and undamaged, with seals and labels intact, unless otherwise indicated.
- B. Store materials in weather protected environment, clear of ground and moisture.

- C. Ensure storage and staging of materials does not exceed static and dynamic load-bearing capacities of roof decking.
- D. Protect foam insulation from direct exposure to sunlight.

1.06 FIELD CONDITIONS

- A. Do not apply roofing membrane during unsuitable weather.
- B. Do not apply roofing membrane when ambient temperature is below 40 degrees F or above 90 degrees F.
- C. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
- D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.
- E. Schedule applications so that no partially completed sections of roof are left exposed at end of workday.

1.07 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Material Warranty: Provide membrane manufacturer's warranty agreeing to replace material that shows manufacturing defects within five years after installation.
- C. System Warranty: Provide manufacturer's system warranty agreeing to repair or replace roofing that leaks or is damaged due to wind or other natural causes.
 - 1. Warranty Term: 20 years No Dollar Limit.
 - 2. For repair and replacement include costs of both material and labor in warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Thermoplastic Polyolefin (TPO) Membrane Roofing Materials:
 - 1. Carlisle SynTec Systems; Sure-Weld TPO: www.carlisle-syntec.com/#sle.
 - 2. Flex Membrane International Corporation; Flex TPO Plus: www.flexroofingsystems.com/#sle.
 - 3. GAF; EverGuard TPO 80 mil: www.gaf.com/#sle.
 - 4. Johns Manville; JM TPO - 80 mil: www.jm.com/#sle.
 - 5. Versico Roofing Systems; VersiWeld TPO: www.versico.com/#sle.
 - 6. Or approved equal.
- B. Insulation:

2.02 ROOFING - UNBALLASTED APPLICATIONS

- A. Thermoplastic Membrane Roofing: One ply membrane, fully adhered, over insulation.
- B. Roofing Assembly Requirements:
 - 1. Solar Reflectance Index (SRI): Minimum of 64 based on three-year aged value; if three-year aged data is not available, minimum of 82 initial value.
 - a. Calculate SRI in accordance with ASTM E1980.
 - b. Field applied coating may not be used to achieve specified SRI.
 - 2. Insulation Thermal Resistance (R-Value): 5 per inch, minimum; provide insulation of thickness required.
- C. Acceptable Insulation Types - Constant Thickness Application: Any of types specified.
 - 1. Minimum 2 layers of polyisocyanurate, extruded polystyrene, or composite board.
- D. Acceptable Insulation Types - Tapered Application: Any of types specified.
 - 1. Tapered polyisocyanurate or extruded polystyrene board.
 - 2. Uniform thickness polyisocyanurate or extruded polystyrene board covered with tapered polyisocyanurate, extruded polystyrene, or perlite board.

2.03 MEMBRANE ROOFING AND ASSOCIATED MATERIALS

- A. Membrane Roofing Materials:
 - 1. TPO: Thermoplastic polyolefin (TPO) complying with ASTM D6878/D6878M, sheet contains reinforcing fabrics or scrims.
 - a. Thickness: 72 mil, 0.072 inch, minimum.
 - 2. Sheet Width:
 - a. Adhered Application: Limit width to 120 inches, maximum, when ambient temperatures are less than 40 degrees F for extended period of time during installation.
 - 3. Color: White.
- B. Seaming Materials: As recommended by membrane manufacturer.
- C. Membrane Fasteners: As recommended and approved by membrane manufacturer.
- D. Vapor Retarder: Material approved by roof manufacturer; compatible with roofing and insulation materials.
- E. Flexible Flashing Material: Same material as membrane.

2.04 INSULATION

- A. Polyisocyanurate (ISO) Board Insulation: Rigid cellular foam, complying with ASTM C1289.
 - 1. Classifications:
 - a. Type I: Faced with aluminum foil on both major surfaces of the core foam.
 - 1) Class 1 - Non-reinforced core foam.
 - 2) Compressive Strength: 16 psi, minimum.
 - 3) Thermal Resistance, R-value: At 1-1/2 inches thick; 9.0, minimum, at 75 degrees F.
 - 2. Board Size: 48 by 96 inches.
 - 3. Board Thickness: 2.0 inches.
 - 4. Tapered Board: Slope as indicated; minimum thickness 1/2 inch; fabricate of fewest layers possible.
 - 5. Board Edges: Square.
- B. Extruded Polystyrene (XPS) Board Insulation: Comply with ASTM C578, with natural skin surface and drainage channels on one face.
 - 1. Board Size: 48 by 96 inches.
 - 2. Board Thickness: 2 inches.
 - 3. Tapered Board: Slope as indicated; minimum thickness 1/2 inch; fabricate of fewest layers possible.
 - 4. Board Edges: Square.
 - 5. Type and Thermal Resistance, R-value (RSI-value): Type XII, 4.6 (0.81), minimum, at 1 inch thick and at 75 degrees F.
 - 6. Type and Compressive Resistance: Type XII, 15 psi (104 kPa), minimum.

2.05 ACCESSORIES

- A. Stack Boots: Prefabricated flexible boot and collar for pipe stacks through membrane; same material as membrane.
- B. Cant and Edge Strips: Wood fiberboard, compatible with roofing materials; cants formed to 45 degree angle.
- C. Insulation Joint Tape: Glass fiber reinforced type as recommended by insulation manufacturer, compatible with roofing materials; 6 inches wide; self adhering.
- D. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.
 - 1. Length as required for thickness of insulation material and penetration of deck substrate, with metal washers.
- E. Membrane Adhesive: As recommended by membrane manufacturer.

- F. Surface Conditioner for Adhesives: Compatible with membrane and adhesives.
- G. Thinners and Cleaners: As recommended by adhesive manufacturer, compatible with membrane.
- H. Insulation Adhesive: As recommended by insulation manufacturer.
- I. Sealants: As recommended by membrane manufacturer.
- J. Walkway Pads: Suitable for maintenance traffic, contrasting color or otherwise visually distinctive from roof membrane.
 - 1. Composition: Asphaltic with mineral granule surface.
 - 2. Surface Color: White or Yellow.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces and site conditions are ready to receive work.
- B. Verify deck is supported and secure.
- C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.
- D. Verify deck surfaces are dry and free of snow or ice.
- E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.

3.02 INSTALLATION, GENERAL

- A. Perform work in accordance with manufacturer's instructions, NRCA (RM), and NRCA (WM) applicable requirements.
- B. Do not apply roofing membrane during cold or wet weather conditions.
- C. Do not apply roofing membrane when ambient temperature is outside the temperature range recommended by manufacturer.
- D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
- E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.
- F. Coordinate this work with installation of associated counterflashings installed by other sections as the work of this section proceeds.

3.03 INSTALLATION - VAPOR RETARDER AND INSULATION, UNDER MEMBRANE

- A. Install vapor retarder to deck surface with adhesive in accordance with manufacturer's instructions.
 - 1. Extend vapor retarder under cant strips and blocking to deck edge.
 - 2. Install flexible flashing from vapor retarder to air seal material of wall construction, lap and seal to provide continuity of the air barrier plane.
- B. Ensure vapor retarder is clean and dry, continuous, and ready for application of insulation.
- C. Attachment of Insulation:
 - 1. Mechanically fasten first layer of insulation to deck in accordance with roofing manufacturer's instructions.
 - 2. Embed second layer of insulation into full bed of adhesive in accordance with roofing and insulation manufacturers' instructions.
- D. Lay subsequent layers of insulation with joints staggered minimum 6 inches from joints of preceding layer.
- E. Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.

- F. On metal deck, place boards parallel to flutes with insulation board edges bearing on deck flutes.
- G. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
- H. Tape joints of insulation in accordance with roofing and insulation manufacturers' instructions.
- I. At roof drains, use factory-tapered boards to slope down to roof drains over a distance of 18 inches.
- J. Do not install more insulation than can be covered with membrane in same day.

3.04 INSTALLATION - MEMBRANE

- A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.
- B. Shingle joints on sloped substrate in direction of drainage.
- C. Fully Adhered Application: Apply adhesive to substrate as recommended by membrane manufacturer. Fully embed membrane in adhesive except in areas directly over or within 3 inches of expansion joints. Fully adhere one roll before proceeding to adjacent rolls.
- D. Overlap edges and ends and seal seams by contact adhesive, minimum 3 inches. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.
- E. At intersections with vertical surfaces:
 - 1. Extend membrane over cant strips and up a minimum of 4 inches onto vertical surfaces.
 - 2. Fully adhere flexible flashing over membrane and up to nailing strips.
- F. Around roof penetrations, seal flanges and flashings with flexible flashing.
- G. Coordinate installation of roof drains and sumps and related flashings.

3.05 CLEANING

- A. Remove bituminous markings from finished surfaces.
- B. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and comply with their documented instructions.
- C. Repair or replace defaced or damaged finishes caused by work of this section.

3.06 PROTECTION

- A. Protect installed roofing and flashings from construction operations.
- B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION

**SECTION 07 62 00
SHEET METAL FLASHING AND TRIM**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Fabricated sheet metal items, including flashings, counterflashings, gutters, and downspouts.
- B. Sealants for joints within sheet metal fabrications.

1.02 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- B. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- C. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
- E. CDA A4050 - Copper in Architecture - Handbook.
- F. ICC (IPC) - International Plumbing Code.
- G. SMACNA (ASMM) - Architectural Sheet Metal Manual.

1.03 SUBMITTALS

- A. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

1.04 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- B. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS**2.01 SHEET MATERIALS**

- A. Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch thick base metal.
- B. Anodized Aluminum: ASTM B209/B209M, 3005 alloy, H12 or H14 temper; 0.032 inch thick; clear anodized finish.
- C. Stainless Steel: ASTM A666/A666M, Type 304 alloy, soft temper, 28 gauge, 0.0156 inch thick; smooth No. 4 - Brushed finish.

2.02 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Form pieces in longest possible lengths.
- C. Hem exposed edges on underside 1/2 inch; miter and seam corners.
- D. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- E. Fabricate corners from one piece with minimum 18-inch long legs; seam for rigidity, seal with sealant.
- F. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.

2.03 GUTTERS AND DOWNSPOUTS

- A. Gutters: SMACNA (ASMM) Rectangular profile.
- B. Downspouts: Rectangular profile.
- C. Gutters and Downspouts: Size for rainfall intensity determined by a storm occurrence of 1 in 10 years in accordance with ICC (IPC).
- D. Accessories: Profiled to suit gutters and downspouts.
 - 1. Gutter Supports: Brackets.
 - 2. Downspout Supports: Brackets.
- E. Downspout Boots: Steel.
- F. Seal metal joints.

2.04 FLASHING

- A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.

2.05 ACCESSORIES

- A. Fasteners: Galvanized steel, with soft neoprene washers.
- B. Primer Type: Zinc chromate.
- C. Concealed Sealants: Non-curing butyl sealant.
- D. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.
- E. Reglets: Surface-mounted type, galvanized steel; face and ends covered with plastic tape.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

- A. Install starter and edge strips, and cleats before starting installation.
- B. Install surface mounted reglets true to lines and levels, and seal top of reglets with sealant.
- C. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil, 0.015 inch.

3.03 INSTALLATION

- A. Insert flashings into reglets to form tight fit; secure in place with plastic wedges; pack remaining spaces with lead wool; seal flashings into reglets with sealant.
- B. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted.
- C. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- D. Seal metal joints watertight.
- E. Secure gutters and downspouts in place with concealed fasteners.
- F. Connect downspouts to downspout boots, and grout connection watertight.

END OF SECTION

**SECTION 07 71 00
ROOF SPECIALTIES****PART 1 GENERAL****1.01 SECTION INCLUDES****1.02 REFERENCE STANDARDS**

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).
- B. ANSI/SPRI/FM 4435/ES-1 - Test Standard for Edge Systems Used with Low Slope Roofing Systems.
- C. NRCA (RM) - The NRCA Roofing Manual.

PART 2 PRODUCTS**2.01 COMPONENTS**

- A. Copings: Factory fabricated to sizes required; corners mitered; concealed fasteners.
 - 1. Configuration: Concealed continuous hold down cleat at both legs; internal splice piece at joints of same material, thickness, and finish as cap; concealed stainless steel fasteners.
 - 2. Pull-Off Resistance: Tested in accordance with ANSI/SPRI/FM 4435/ES-1 using test method RE-3 to positive and negative design wind pressure as defined by applicable local building code.
 - 3. Wall Width: As indicated on drawings.
 - 4. Outside Face Height: 6 inches.
 - 5. Inside Face Height: 4 inches.
 - 6. Material: Formed steel sheet, galvanized, 24 gauge, 0.024 inch thick, minimum.
 - 7. Finish: 70 percent polyvinylidene fluoride.
 - 8. Color: As selected by Contracting Officer or Contracting Officer's Representative from manufacturer's standard range.
 - 9. Products:
 - a. ATAS International, Inc; Rapid-Lok Coping: www.atas.com/#sle.
 - b. Hickman Edge Systems; PermaSnap Cantilever Coping: www.hickmanedgesystems.com/#sle.
 - c. Metal-Era Inc; One Edge Coping: www.metalera.com/#sle.
 - d. Or approved equal.

2.02 FINISHES

- A. PVDF (Polyvinylidene Fluoride) Coating: Superior Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system; color as indicated.

2.03 ACCESSORIES

- A. Sealant for Joints in Linear Components: As recommended by component manufacturer.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that deck, curbs, roof membrane, base flashing, and other items affecting work of this Section are in place and positioned correctly.

3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.
- B. Seal joints within components when required by component manufacturer.
- C. Anchor components securely.

- D. Coordinate installation of components of this section with installation of roofing membrane and base flashings.
- E. Coordinate installation of sealants and roofing cement with work of this section to ensure water tightness.
- F. Coordinate installation of flashing flanges into reglets.

END OF SECTION

**SECTION 07 72 00
ROOF ACCESSORIES****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Roof curbs.
- B. Roof penetrations mounting curbs.
- C. Roof hatches and safety rails.
- D. Snow guards.

1.02 REFERENCE STANDARDS

- A. 29 CFR 1910.23 - Ladders.
- B. 29 CFR 1910.29 - Fall Protection Systems and Falling Object Protection - Criteria and Practices.
- C. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- D. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).

1.03 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used.
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
 - 4. Maintenance requirements.
- B. Shop Drawings: Submit detailed layout developed for this project and provide dimensioned location and number for each type of roof accessory.
 - 1. Snow Guards: Submit design calculations for loadings and spacings based on manufacturer testing.
 - 2. Submit shop drawings sealed and signed by a Professional Engineer experienced in design of this type of work and licensed in the Commonwealth of Pennsylvania.
- C. Warranty Documentation:
 - 1. Submit manufacturer warranty.
 - 2. Ensure that forms have been completed in Government's name and registered with manufacturer.
 - 3. Submit documentation that roof accessories are acceptable to roofing manufacturer, and do not limit the roofing warranty.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store products under cover and elevated above grade.

1.05 WARRANTY

- A. Manufacturer Warranty: Provide 2-year manufacturer warranty for snow guards. Complete forms in Government's name and register with manufacturer.
- B. Extended Correction Period: Correct defective work within 5-year period commencing on Date of Substantial Completion.

PART 2 PRODUCTS**2.01 ROOF CURBS**

- A. Roof Curbs Mounting Assemblies: Factory fabricated hollow sheet metal construction, internally reinforced, and capable of supporting superimposed live and dead loads and

designated equipment load with fully mitered and sealed corner joints welded or mechanically fastened, and integral counterflashing with top and edges formed to shed water.

1. Applications: Roof curbs used for roof penetrations/openings as indicated on drawings.
 2. Roof Curb Mounting Substrate: Curb substrate consists of flat roof deck sheathing with insulation.
 3. Sheet Metal Material:
 - a. Aluminum: 0.080 inch minimum thickness, with 3003 alloy, and H14 temper.
 - 1) Color: As selected by Architect from manufacturer's standard line of colors.
 4. Roofing Cants: Provide integral sheet metal roofing cants dimensioned to begin slope at top of roofing system at 1:1 slope; minimum cant height 4 inches.
- B. Roof Curb Caps: Square-type aluminum cap with weathertight seal when vent or equipment is not installed.
- C. Curbs Adjacent to Roof Openings: Provide curb on each side of opening, with top of curb horizontal for equipment mounting.
1. Provide preservative treated wood nailers along top of curb.
 2. Insulate inside curbs with 1-1/2 inch thick fiberglass insulation.
 3. Height Above Finished Roof Surface: 8 inches, minimum.
- D. Pipe, Duct, or Conduit Mounting Curbs: Vertical posts, minimum 8 inches square unless otherwise indicated.
1. Provide sliding channel welded along top edge with adjustable height steel bracket, fabricated to fit item supported.
 2. Height Above Finished Roof Surface: 8 inches, minimum.

2.02 ROOF HATCHES AND VENTS

- A. Roof Hatch Manufacturers:
1. Babcock-Davis: www.babcockdavis.com/#sle.
 2. Best Access Doors: www.bestaccessdoors.com/#sle.
 3. Bilco Company; Type S: www.bilco.com/#sle.
 4. FAKRO America LLC: www.fakrousa.com/#sle.
 5. Precision Ladders, LLC: www.precisionladders.com/#sle.
 6. OR approved equal.
- B. Roof Hatches and Smoke Vents: Factory-assembled aluminum frame and cover, complete with operating and release hardware.
1. Style: Provide flat metal covers unless otherwise indicated.
 2. Thermally Broken Hatches: Provide insulation within frame and cover.
 3. For Ladder Access: Single leaf; 30 by 36 inches.
- C. Frames and Curbs: One-piece curb and frame with integral cap flashing to receive roof flashings; extended bottom flange to suit mounting.
1. Insulation: Manufacturer's standard; 1 inch rigid glass fiber, located on outside face of curb.
 2. Curb Height: 12 inches from finished surface of roof, minimum.
- D. Metal Covers: Flush, insulated, hollow metal construction.
1. Capable of supporting 40 psf live load.
 2. Insulation: Manufacturer's standard 1 inch rigid glass fiber.
 3. Gasket: Neoprene, continuous around cover perimeter.
- E. Safety Railing System: Roof hatch safety rail system mounted directly to curb without penetration of roofing system.
- F. Hardware: Steel, zinc coated and chromate sealed, unless otherwise indicated or required by manufacturer.
1. Lifting Mechanisms: Compression or torsion spring operator with shock absorbers that automatically opens upon release of latch; capable of lifting covers despite 10 psf load.

2. Hinges: Heavy duty pintle type.
3. Hold open arm with vinyl-coated handle for manual release.
4. Latch: Upon closing, engage latch automatically and reset manual release.
5. Manual Release: Pull handle on interior.
6. Locking: Padlock hasp on interior.

2.03 NON-PENETRATING ROOFTOP SUPPORTS/ASSEMBLIES

- A. Safety Railing System: Roof hatch safety rail system mounted directly to curb without penetration of roofing system.
 1. Railing Size: 30 by 36 inches.
 2. Railing: Comply with 29 CFR 1910.23 for ladder safety, with safety factor of two.
 3. Self-Closing Gate: Comply with 29 CFR 1910.29 for safe egress and fall protection through hatch opening.
 4. Posts and Rails: Fiberglass-reinforced polymer tubing.
 5. Gate: Same material as railing; automatic closing with latch.
 6. Finish: Manufacturer's standard, factory-applied.
 7. Gate Hinges and Post Guides: ASTM B221 (ASTM B221M), 6063 alloy, T5 temper aluminum.
 8. Mounting Brackets: Hot-dip galvanized steel, 1/4 inch thick, minimum.
 9. Fasteners: Stainless steel, Type 316.
 10. Products:
 - a. Activar Construction Products Group, Inc - JL Industries: www.activarcpg.com/#sle.
 - b. Babcock-Davis; Safety Railings: www.babcockdavis.com/#sle.
 - c. BILCO Company; Bil-Guard 2.0: www.bilco.com/#sle.
 - d. Nystrom, Inc; Safety Railings: www.nystrom.com/#sle.
 - e. Safety Rail Company; Roof HatchGuard, Non-Penetrating Fall Protection: www.safetyrailcompany.com/#sle.
 - f. Or approved equal.

2.04 SNOW GUARDS

- A. Fence Type Snow Guard: Continuous snow guard; manufacturer's standard pipe, bar, channel, or solid rod, set in brackets or posts, with optional plates and metal trim to match roof.
 1. Brackets: Aluminum.
 2. Extruded Aluminum Channel: Manufacturer's standard shape; with slot for insertion of metal trim matching roof.
 3. Supplemental Plates and Clips: Attached to horizontal component; match finish of pipe, tube, rod, or channel.
 4. Clamps for Standing Seam Roof: Aluminum clamps attached to standing seams of roof panels; for attachment of fence type snow guard.
 - a. Seam Profile: Selected by Contracting Officer or Contracting Officer's Representative from manufacturer's standard range; match profile of metal roof.
 - b. Finish: Mill finish.
 5. Products:
 - a. Alpine SnowGuards: www.alpinesnowguards.com/#sle.
 - b. Berger Building Products: www.bergerbp.com/#sle.
 - c. Construction Metal Products, Inc; Construction Metal Snow Guards: www.aceclamp.com/#sle.
 - d. Metal Roof Innovations, Ltd. S-5! Attachment Solutions; ColorGard: www.s-5.com/#sle.
 - e. Rocky Mountain Snow Guards, Inc: www.rockymountainsnowguards.com/#sle.
 - f. OR approved equal.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Contracting Officer or Contracting Officer's Representative of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using methods recommended by manufacturer for achieving acceptable results for applicable substrate under project conditions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions, in manner that maintains roofing system weather-tight integrity.

3.04 CLEANING

- A. Clean installed work to like-new condition.

3.05 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

**SECTION 07 84 00
FIRESTOPPING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Firestopping systems.

1.02 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.
- C. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
- D. ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed between Rated Wall Assemblies and Nonrated Horizontal Assemblies.
- E. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- F. ITS (DIR) - Directory of Listed Products.
- G. FM (AG) - FM Approval Guide.
- H. SCAQMD 1168 - Adhesive and Sealant Applications.
- I. UL 1479 - Standard for Fire Tests of Penetration Firestops.
- J. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems.
- K. UL (FRD) - Fire Resistance Directory.

1.03 SUBMITTALS

- A. Sustainable Design Submittal: Submit VOC content documentation for nonpreformed materials.
- B. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer's qualification statement.

1.04 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
 - 1. Listing in UL (FRD), FM (AG), or ITS (DIR) will be considered as constituting an acceptable test report.
 - 2. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.05 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials.
- B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Firestopping Materials: Any materials meeting requirements.

- B. Volatile Organic Compound (VOC) Content: Provide products having VOC content lower than that required by SCAQMD 1168.
- C. Mold and Mildew Resistance: Provide firestopping materials with mold and mildew resistance rating of zero(0) in accordance with ASTM G21.
- D. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.
- E. Fire Ratings: Refer to drawings for required systems and ratings.

2.02 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A. Head-of-Wall (HW) Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of wall assembly.
 - 1. Movement: Provide systems that have been tested to show movement capability as indicated.
- B. Floor-to-Floor (FF), Floor-to-Wall (FW), Head-of-Wall (HW), and Wall-to-Wall (WW) Joints, Except Perimeter, Where Both Are Fire-Rated: Use system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
- C. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.

2.03 FIRESTOPPING SYSTEMS

- A. Firestopping: Any material meeting requirements.
 - 1. Fire Ratings: Use system that is listed by FM (AG), ITS (DIR), or UL (FRD) and tested in accordance with ASTM E814, ASTM E119, or UL 1479 with F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and in compliance with other specified requirements.
 - 2. Fire Ratings: See drawings for required systems and ratings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.
- C. Install backing materials to prevent liquid material from leakage.

3.03 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Do not cover installed firestopping until inspected by authorities having jurisdiction.
- C. Install labeling required by code.

3.04 FIELD QUALITY CONTROL

- A. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

3.05 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.06 PROTECTION

- A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

**SECTION 07 92 00
JOINT SEALANTS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Nonsag gunnable joint sealants.
- B. Joint backings and accessories.

1.02 REFERENCE STANDARDS

- A. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
- B. ASTM C794 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
- C. ASTM C834 - Standard Specification for Latex Sealants.
- D. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications.
- E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
- F. ASTM C1087 - Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.
- G. ASTM C1193 - Standard Guide for Use of Joint Sealants.
- H. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants.
- I. ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
- J. ASTM C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.
- K. SCAQMD 1168 - Adhesive and Sealant Applications.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical datasheets for each product to be used; include the following:
 - 1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
 - 2. List of backing materials approved for use with the specific product.
 - 3. Backing material recommended by sealant manufacturer.
 - 4. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
 - 5. Substrates the product should not be used on.
 - 6. Substrates for which use of primer is required.
- B. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.
- C. Color Cards for Selection: Where sealant color is not specified, submit manufacturer's color cards showing standard colors available for selection.
- D. Preconstruction Laboratory Test Reports: Submit at least four weeks prior to start of installation.
- E. Field Quality Control Plan: Submit at least two weeks prior to start of installation.
- F. Field Quality Control Log: Submit filled-out log for each length or instance of sealant installed, within 10 days after completion of inspections/tests; include bagged test samples and photographic records, if any.
- G. Manufacturer's qualification statement.
- H. Executed warranty.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.
- C. Preconstruction Laboratory Testing: Arrange for sealant manufacturer(s) to test each combination of sealant, substrate, backing, and accessories.
 - 1. Adhesion Testing: In accordance with ASTM C794.
 - 2. Compatibility Testing: In accordance with ASTM C1087.
 - 3. Allow sufficient time for testing to avoid delaying the work.
 - 4. Deliver sufficient samples to manufacturer for testing.
 - 5. Report manufacturer's recommended corrective measures, if any, including primers or techniques not indicated in product data submittals.
- D. Field Quality Control Plan:
 - 1. Visual inspection of entire length of sealant joints.
 - 2. Nondestructive field adhesion testing of sealant joints, except interior acrylic latex sealants.
 - a. For each different sealant and substrate combination, allow for one test every 12 inches in the first 10 linear feet of joint and one test every 24 inches thereafter.
 - b. If any failures occur in the first 10 linear feet, continue testing at 12 inches intervals at no extra cost to Government.
 - 3. Field testing agency's qualifications.
 - 4. Field Quality Control Log Form: Show same data fields as on Preinstallation Field Adhesion Test Log, with known information filled out and lines for multiple tests per sealant/substrate combinations; include visual inspection and specified field testing; allow for possibility that more tests than minimum specified may be necessary.
- E. Field Adhesion Test Procedures:
 - 1. Allow sealants to fully cure as recommended by manufacturer before testing.
 - 2. Have a copy of the test method document available during tests.
 - 3. Record the type of failure that occurred, other information required by test method, and the information required on the Field Quality Control Log.
 - 4. If any combination of sealant type and substrate does not show evidence of minimum adhesion or shows cohesion failure before minimum adhesion, report results to Contracting Officer or Contracting Officer's Representative.
- F. Nondestructive Field Adhesion Test: Test for adhesion in accordance with ASTM C1521, using Nondestructive Spot Method.

1.05 WARRANTY

- A. Manufacturer Warranty: Provide 2-year manufacturer warranty for installed sealants and accessories that fail to achieve a watertight seal, exhibit loss of adhesion or cohesion, or do not cure. Complete forms in Government's name and register with manufacturer.

PART 2 PRODUCTS**2.01 JOINT SEALANT APPLICATIONS**

- A. Scope:
 - 1. Exterior Joints:
 - a. Do not seal exterior joints unless indicated on drawings as sealed.
 - b. Seal the following joints:
 - 1) Wall expansion and control joints.
 - 2) Joints between doors, windows, and other frames or adjacent construction.
 - 3) Joints between different exposed materials.
 - 2. Interior Joints:

- a. Do not seal gaps and openings in gypsum board and suspended ceilings
- b. Do not seal through-penetrations in sound-rated assemblies that are also fire-rated assemblies.
- c. Seal the following joints:
 - 1) Joints between door frames and window frames and adjacent construction.
 - 2) In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, and piping penetrations.
- 3. Do Not Seal:
 - a. Intentional weep holes in masonry.
 - b. Joints indicated to be covered with expansion joint cover assemblies or other covering devices.
 - c. Joints between suspended ceilings and walls.
- B. Exterior Joints: Use nonsag nonstaining silicone sealant, unless otherwise indicated.
 - 1. Lap Joints in Sheet Metal Fabrications: Butyl rubber, noncuring.
 - 2. Control and Expansion Joints in Concrete Paving: Self-leveling polyurethane traffic-grade sealant.
- C. Interior Joints: Use nonsag polyurethane sealant, unless otherwise indicated.
 - 1. Wall and Ceiling Joints in Nonwet Areas: Acrylic emulsion latex sealant.
 - 2. Wall and Ceiling Joints in Wet Areas: Nonsag polyurethane sealant for continuous liquid immersion.
 - 3. Floor Joints in Wet Areas: Nonsag polyurethane non-traffic-grade sealant suitable for continuous liquid immersion.
 - 4. Joints between Tile in Wet Areas and Floors, Walls, and Ceilings: Mildew-resistant silicone sealant; white.
 - 5. In Sound-Rated Assemblies: Acrylic emulsion latex sealant.
- D. Interior Wet Areas: restrooms; fixtures in wet areas include plumbing fixtures and countertops.
- E. Sound-Rated Assemblies: Walls and ceilings identified as STC-rated, sound-rated, or acoustical.

2.02 JOINT SEALANTS - GENERAL

- A. Sealants and Primers: Provide products having lower volatile organic compound (VOC) content than indicated in SCAQMD 1168.
- B. Colors: As indicated on drawings.

2.03 NONSAG JOINT SEALANTS

- A. Nonstaining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
 - 1. Movement Capability: Plus and minus 50 percent, minimum.
 - 2. Nonstaining to Porous Stone: Nonstaining to light-colored natural stone when tested in accordance with ASTM C1248.
 - 3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
 - 4. Hardness Range: 15 to 35, Shore A, when tested in accordance with ASTM C661.
 - 5. Color: Match adjacent finished surfaces.
 - 6. Cure Type: Single-component, neutral moisture curing.
 - 7. Service Temperature Range: Minus 20 to 180 degrees F.
 - 8. Products:
 - a. Dow; DOWSIL 791 Silicone Weatherproofing Sealant: www.dow.com/#sle.
 - b. Sika Corporation; Sikasil WS-295: usa.sika.com/#sle.
 - c. Tremco Commercial Sealants & Waterproofing; Tremsil 400: www.tremcosealants.com/#sle.
 - d. Or approved equal.

- B. Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.
1. Color: White.
 2. Products:
 - a. Pecora Corporation; Pecora 898 NST (Non-Staining Technology): www.pecora.com/#sle.
 - b. Sika Corporation; Sikasil N Plus US: usa.sika.com/#sle.
 - c. Or approved equal.
- C. Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single component; not expected to withstand continuous water immersion or traffic.
1. Movement Capability: Plus and minus 50 percent, minimum.
 2. Hardness Range: 20 to 35, Shore A, when tested in accordance with ASTM C661.
 3. Color: Match adjacent finished surfaces.
 4. Service Temperature Range: Minus 40 to 180 degrees F.
 5. Products:
 - a. Pecora Corporation; DynaTrol II: www.pecora.com/#sle.
 - b. Sherwin-Williams Company; Stampede-1/-TX Polyurethane Sealant: www.sherwin-williams.com/#sle.
 - c. Sika Corporation; Sikaflex-15 LM: usa.sika.com/#sle.
 - d. Or approved equal.
- D. Polyurethane Sealant for Continuous Water Immersion: ASTM C920, Grade NS, Uses M and A; single component; explicitly approved by manufacturer for continuous water immersion; suitable for traffic exposure when recessed below traffic surface.
1. Movement Capability: Plus and minus 35 percent, minimum.
 2. Water Compatibility: Non-Potable.
 3. Hardness Range: 20 to 35, Shore A, when tested in accordance with ASTM C661.
 4. Color: Match adjacent finished surfaces.
 5. Service Temperature Range: Minus 40 to 180 degrees F.
 6. Products:
 - a. Sika Corporation; Sikaflex-1A: usa.sika.com/#sle.
 - b. Or approved equal.
- E. Acrylic Emulsion Latex: Water-based; ASTM C834, single component, nonstaining, nonbleeding, nonsagging; not intended for exterior use.
1. Color: Standard colors matching finished surfaces, Type OP (opaque).
 2. Grade: ASTM C834; Grade 0 Degrees F (Minus 18 Degrees C).
 3. Products:
 - a. Franklin International, Inc; Titebond Pro-Grade Caulk: www.titebond.com/#sle.
 - b. Hilti, Inc; CP 506 Smoke and Acoustical Sealant: www.us.hilti.com/#sle.
 - c. Pecora Corporation; AC-20 +Silicone: www.pecora.com/#sle.
 - d. Sherwin-Williams Company; 850A Acrylic Latex Caulk: www.sherwin-williams.com/#sle.
 - e. Tremco Commercial Sealants & Waterproofing; Tremflex 834: www.tremcosealants.com/#sle.
 - f. Or approved equal.
- F. Noncuring Butyl Sealant: Solvent-based, single component, nonsag, nonskinning, nonhardening, nonbleeding; nonvapor permeable; intended for fully concealed applications.
1. Products:
 - a. Pecora Corporation; Pecora BA-98 Non-Skinning Butyl Sealant: www.pecora.com/#sle.
 - b. Or approved equal.

2.04 ACCESSORIES

- A. Sealant Backing Rod, Closed-Cell Type:
 - 1. Cylindrical flexible sealant backings complying with ASTM C1330 Type C.
 - 2. Size: 25 to 50 percent larger in diameter than joint width.
- B. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.
- C. Masking Tape: Self-adhesive, nonabsorbent, nonstaining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.
- D. Joint Cleaner: Noncorrosive and nonstaining type, type recommended by sealant manufacturer; compatible with joint forming materials.
- E. Primers: Type recommended by sealant manufacturer to suit application; nonstaining.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that joints are ready to receive work.
- B. Verify that backing materials are compatible with sealants.
- C. Verify that backer rods are of the correct size.

3.02 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

3.03 INSTALLATION

- A. Install this work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Provide joint sealant installations complying with ASTM C1193.
- C. Install acoustical sealant application work in accordance with ASTM C919.
- D. Measure joint dimensions and size joint backers to achieve the following, unless otherwise indicated:
 - 1. Width/depth ratio of 2:1.
 - 2. Neck dimension no greater than 1/3 of the joint width.
 - 3. Surface bond area on each side not less than 75 percent of joint width.
- E. Install bond breaker backing tape where backer rod cannot be used.
- F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- G. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
- H. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

3.04 FIELD QUALITY CONTROL

- A. Perform field quality control inspection/testing as specified in PART 1 under QUALITY ASSURANCE article.
- B. Non-Destructive Adhesion Testing: If there are any failures in first 100 linear feet, notify Contracting Officer or Contracting Officer's Representative immediately.

- C. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

END OF SECTION

**SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Non-fire-rated hollow metal doors and frames.
- B. Hollow metal frames for wood doors.
- C. Fire-rated hollow metal doors and frames.
- D. Thermally insulated hollow metal doors with frames.
- E. Sensitive Compartmented Information Facility (SCIF) doors and frames.
- F. Accessories, including glazing.

1.02 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design.
- B. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors.
- C. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
- D. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100).
- E. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- G. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable.
- H. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- J. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- K. ASTM E336 - Standard Test Method for Measurement of Airborne Sound Attenuation Between Rooms in Buildings.
- L. ASTM E413 - Classification for Rating Sound Insulation.
- M. BHMA A156.115 - Hardware Preparation in Steel Doors and Steel Frames.
- N. ICC A117.1 - Accessible and Usable Buildings and Facilities.
- O. ITS (DIR) - Directory of Listed Products.
- P. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames.
- Q. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames.
- R. NAAMM HMMA 840 - Guide Specifications For Receipt, Storage and Installation of Hollow Metal Doors and Frames.
- S. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames.
- T. NCSC (TS) - Technical Specifications for Construction and Management of Sensitive Compartmented Information Facilities.
- U. NFPA 80 - Standard for Fire Doors and Other Opening Protectives.

- V. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.
- W. UL (DIR) - Online Certifications Directory.
- X. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies.

1.03 SUBMITTALS

- A. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes.
- B. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.
- C. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.
- D. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.
- E. Manufacturer's Qualification Statement.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Hollow Metal Doors and Frames:
 - 1. Ceco Door, an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 2. Curries, an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 3. Mesker, dormakaba Group; FDJ Series Drywall Frames: www.meskeropeningsgroup.com/#sle.
 - 4. Republic Doors, an Allegion brand: www.republicdoor.com/#sle.
 - 5. Steelcraft, an Allegion brand: www.allegion.com/#sle.
 - 6. Or approved equal.
- B. Sound-Rated Hollow Metal Doors and Frames:
 - 1. AMBICO Limited: www.ambico.com/#sle.
 - 2. De La Fontaine; STC - Acoustical Core: www.delafontaine.com/#sle.
 - 3. Overly Door Company: www.overly.com/#sle.
 - 4. Or approved equal.

2.02 PERFORMANCE REQUIREMENTS

- A. Requirements for Hollow Metal Doors and Frames:
 - 1. Steel Sheet: Comply with one or more of the following requirements; galvanized steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
 - 2. Accessibility: Comply with ICC A117.1 and ADA Standards.
 - 3. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
 - 4. Zinc Coating for Typical Interior and/or Exterior Locations: Provide metal components zinc-coated (galvanized) and/or zinc-iron alloy-coated (galvanized) by the hot-dip

process in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness, unless noted otherwise for specific hollow metal doors and frames.

- a. Based on SDI Standards: Provide at least A40/ZF120 (galvannealed) when necessary, coating not required for typical interior door applications, and at least A60/ZF180 (galvannealed) for corrosive locations.
- B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 HOLLOW METAL DOORS

- A. Exterior Doors: Thermally insulated.
 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 2 - Heavy-duty.
 - b. Physical Performance Level B, 500,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 18 gauge, 0.042 inch, minimum.
 - e. Zinc Coating: A60/ZF180 galvannealed coating; ASTM A653/A653M.
 2. Door Core Material: Polyurethane, 1.8 lbs/cu ft minimum density.
 - a. Foam Plastic Insulation: Manufacturer's standard board insulation with maximum flame spread index (FSI) of 75, and maximum smoke developed index (SDI) of 450 in accordance with ASTM E84, and completely enclosed within interior of door.
 3. Door Thermal Resistance: R-Value of 8.7, minimum, for installed thickness of polyurethane.
 4. Door Thickness: 1-3/4 inches, nominal.
 5. Top Closures for Outswinging Doors: Flush with top of faces and edges.
 6. Door Face Sheets: Flush.
 7. Weatherstripping: Refer to Section 08 71 00.
 8. Door Finish: Factory primed and field finished.
- B. Interior Doors, Non-Fire-Rated:
 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 2 - Heavy-duty.
 - b. Physical Performance Level B, 500,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 18 gauge, 0.042 inch, minimum.
 2. Door Thickness: 1-3/4 inches, nominal.
 3. Door Face Sheets: Flush.
 4. Door Finish: Factory primed and field finished.
- C. Fire-Rated Doors:
 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 2 - Heavy-duty.
 - b. Physical Performance Level B, 500,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 18 gauge, 0.042 inch, minimum.
 2. Fire Rating: As indicated on Door Schedule, tested in accordance with UL 10C and NFPA 252 ("positive pressure fire tests").
 3. Provide units listed and labeled by UL (DIR) or ITS (DIR).
 - a. Attach fire rating label to each fire rated unit.
 4. Door Core Material: Manufacturers standard core material/construction in compliance with requirements.
 5. Door Thickness: 1-3/4 inches, nominal.
 6. Door Finish: Factory primed and field finished.

- D. Sensitive Compartmented Information Facility (SCIF) Interior Assemblies:
1. Provide sound-rated door assembly in compliance with NCSC (TS) and other related documents; comply with ASTM E336 test methods for measurement of sound between rooms.
 2. Integrated Door, Frame, and Hardware Assemblies: Provide manufacturer's standard assemblies comprised of compatible components.
 - a. Sound Transmission Class (STC) Rating of Door and Frame Assembly: Up to STC of 45, minimum, calculated in accordance with ASTM E413, and tested in accordance with ASTM E90.
 - b. Doors: Manufacturer's standard doors designed to comply with performance requirements indicated.
 - 1) Door Core Material: Manufacturer's standard construction as required to meet acoustic requirements indicated.
 - 2) Door Thickness: As required to meet acoustic requirements indicated.
 - 3) Door Face Sheets: Flush.
 - 4) Door Finish: Factory primed and field finished.
 - 5) Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - (a) Level 3 - Extra Heavy-duty.
 - (b) Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
 - (c) Model 1 - Full Flush.
 - (d) Door Face Metal Thickness: 16 gauge, 0.053 inch, minimum.
 - c. Frames: Fully-welded 14 gauge, 0.067 inch, minimum.
 - 1) Zinc Coating: G90/Z275 galvanized coating; ASTM A653/A653M.
 - 2) Frame Finish: Factory primed and field finished.
 - d. Hardware: Manufacturer's standard for SCIF assemblies.
 - 1) Locksets: As specified in Section 08 71 00.
 - 2) Cam-Lift Hinges: 3 heavy-weight hinges.
 - 3) Closers: Manufacturer's standard heavy-duty surface-mounted units.
 - (a) Opening Force of Doors: 5 pounds, maximum, in compliance with ADA Standards.
 - 4) Thresholds: Manufacturer's standard, selected to work with door bottom seals.
 - 5) Sound Seals: Integral, in door and/or frame.
 - 6) Automatic Door Bottoms: Manufacturer's standard, concealed type.
 - 7) Door Position Switches: Manufacturer's standard mated magnetic switch and magnetic contacts.
 - (a) Include electric power transfer devices with wiring through door.

2.04 HOLLOW METAL FRAMES

- A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- B. Exterior Door Frames: Knock-down type.
 1. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A40/ZF120 coating.
 2. Frame Metal Thickness: 16 gauge, 0.053 inch, minimum.
 3. Frame Finish: Factory primed and field finished.
 4. Weatherstripping: Separate, see Section 08 71 00.
- C. Interior Door Frames, Non-Fire Rated: Slip-on type at gypsum board walls, and knock-down type at masonry walls.
 1. Frame Metal Thickness: 16 gauge, 0.053 inch, minimum.
 2. Frame Finish: Factory primed and field finished.
- D. Door Frames, Fire-Rated: Knock-down type.
 1. Fire Rating: Same as door, labeled.

2. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.
 3. Frame Finish: Factory primed and field finished.
- E. Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.
- F. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches high to fill opening without cutting masonry units.

2.05 FINISHES

- A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

2.06 ACCESSORIES

- A. Glazing: As specified in Section 08 80 00, factory installed.
- B. Removable Stops: Formed sheet steel, shape as indicated on drawings, mitered or butted corners; prepared for countersink style tamper proof screws.
- C. Mechanical Fasteners for Concealed Metal-to-Metal Connections: Self-drilling, self-tapping, steel with electroplated zinc finish.
- D. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.
- E. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Verify that finished walls are in plane to ensure proper door alignment.

3.02 PREPARATION

- A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

3.03 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
- B. Install fire rated units in accordance with NFPA 80.
- C. Coordinate frame anchor placement with wall construction.
- D. Install door hardware as specified in Section 08 71 00.
1. Comply with recommended practice for hardware placement of doors and frames in accordance with ANSI/SDI A250.6 or NAAMM HMMA 861.
- E. Comply with glazing installation requirements of Section 08 80 00.
- F. Coordinate installation of electrical connections to electrical hardware items.
- G. Touch up damaged factory finishes.

3.04 TOLERANCES

- A. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.05 ADJUSTING

- A. Adjust for smooth and balanced door movement.
- B. Test sound control doors for force to close, latch, and unlatch; adjust as necessary in compliance with requirements.

3.06 SCHEDULE

- A. Refer to Door and Frame Schedule on the drawings.

END OF SECTION

**SECTION 08 14 16
FLUSH WOOD DOORS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Flush wood doors; flush and flush glazed configuration; fire-rated and non-rated.

1.02 REFERENCE STANDARDS

- A. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
- B. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition.
- C. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards.
- D. NFPA 80 - Standard for Fire Doors and Other Opening Protectives.
- E. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies.

1.03 SUBMITTALS

- A. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
- B. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
- C. Samples: Submit two samples of door veneer, 4 by 4 inches in size illustrating wood grain, stain color, and sheen.
- D. Warranty, executed in Government's name.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section, with not less than three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Package, deliver and store doors in accordance with specified quality standard.
- B. Accept doors on site in manufacturer's packaging, and inspect for damage.
- C. Protect doors with resilient packaging sealed with heat shrunk plastic; do not store in damp or wet areas or areas where sunlight might bleach veneer; seal top and bottom edges with tinted sealer if stored more than one week, and break seal on site to permit ventilation.

1.06 WARRANTY

- A. Manufacturer Warranty: Provide manufacturer's warranty on interior doors for the life of the installation. Complete forms in Government's name and register with manufacturer.
 - 1. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Wood Veneer Faced Doors:
 - 1. Haley Brothers: www.haleybros.com/#sle.
 - 2. VT Industries, Inc: www.vtindustries.com/#sle.
 - 3. Or approved equal.

2.02 DOORS AND PANELS

- A. Doors: See drawings for locations and additional requirements.
 - 1. Quality Standard: Premium Grade, Standard Duty performance, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
 - 2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.
- B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.

1. Provide solid core doors at each location.
2. Fire Rated Doors: Tested to ratings indicated on drawings in accordance with UL 10C - Positive Pressure; Underwriters Laboratories Inc (UL) or Intertek/Warnock Hersey (WHI) labeled without any visible seals when door is open.
3. Wood veneer facing with factory transparent finish.

2.03 DOOR AND PANEL CORES

- A. Fire-Rated Doors: Mineral core type, with fire resistant composite core (FD), plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.

2.04 DOOR FACINGS

- A. Veneer Facing for Transparent Finish: White birch, veneer grade in accordance with quality standard indicated, plain sliced (flat cut), with book match between leaves of veneer, running match of spliced veneer leaves assembled on door or panel face.
 1. Vertical Edges: Any option allowed by quality standard for grade.
- B. Facing Adhesive: Type I - waterproof.

2.05 DOOR CONSTRUCTION

- A. Fabricate doors in accordance with door quality standard specified.
- B. Glazed Openings: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.
- C. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.
- D. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
- E. Provide edge clearances in accordance with the quality standard specified.

2.06 FINISHES - WOOD VENEER DOORS

- A. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:
 1. Transparent:
 - a. System - 1, Lacquer, Nitrocellulose.
 - b. Stain: As selected by Contracting Officer or Contracting Officer's Representative.
 - c. Sheen: Flat.
- B. Factory finish doors in accordance with approved sample.
- C. Seal door top edge with color sealer to match door facing.

2.07 ACCESSORIES

- A. Hollow Metal Door Frames: See Section 08 11 13.
- B. Glazed Openings:
 1. Heat-Strengthened and Fully Tempered Glass: ASTM C1048.
 2. Glazing: Single vision units, 1/4 inch thick glass.
 3. Tint: Clear.
- C. Glazing Stops: Wood, of same species as door facing, butted corners; prepared for countersink style tamper proof screws.
- D. Door Hardware: See Section 08 71 00.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.

- C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.02 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions and specified quality standard.
 - 1. Install fire-rated doors in accordance with NFPA 80 requirements.
- B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
- C. Use machine tools to cut or drill for hardware.
- D. Coordinate installation of doors with installation of frames and hardware.
- E. Coordinate installation of glazing.

3.03 TOLERANCES

- A. Comply with specified quality standard for fit and clearance tolerances.
- B. Comply with specified quality standard for telegraphing, warp, and squareness.

3.04 ADJUSTING

- A. Adjust doors for smooth and balanced door movement.
- B. Adjust closers for full closure.

END OF SECTION

SECTION 08 36 13
SECTIONAL OVERHEAD DOORS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Insulated Sectional Overhead Doors.
- B. Electric Operators and Controls.
- C. Operating Hardware, tracks, and support.

1.02 REFERENCE STANDARDS

- A. DASMA 102 - American National Standard Specifications for Sectional Overhead Type Doors.
- B. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems.

1.03 REFERENCES

- A. ANSI/DASMA 102 - American National Standard Specifications for Sectional Overhead Type Doors.

1.04 DESIGN / PERFORMANCE REQUIREMENTS

- A. Wiring Connections: Requirements for electrical characteristics.
 - 1. 460 volts, three phase, 60 Hz.
- B. Single-Source Responsibility: Provide doors, tracks, motors, and accessories from one manufacturer.

1.05 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- B. Shop Drawings: Indicate plans and elevations including opening dimensions and required tolerances, connection details, anchorage spacing, hardware locations, and installation details.
- C. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- D. Operation and Maintenance Data.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years documented experience.
- B. Installer Qualifications: Authorized representative of the manufacturer with minimum five years documented experience.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc. acceptable to authority having jurisdiction as suitable for purpose specified.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened labeled packaging until ready for installation.
- B. Protect materials from exposure to moisture until ready for installation.
- C. Store materials in a dry, ventilated weathertight location.

1.08 WARRANTY

- A. Manufacturer Warranty: Provide manufacturer warranty for counterbalance shaft assembly for 3 years. Complete forms in the government's name and register with manufacturer.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Basis of Design: Overhead Door Corporation.

- B. Other acceptable manufacturers
 - 1. C.H.I. Overhead Doors.
 - 2. Raynor Garage Doors.
 - 3. Or approved equal.

2.02 INSULATED SECTIONAL OVERHEAD DOORS

- A. Insulated Steel Sectional Overhead Doors: Model 418 Insulated Steel Doors by Overhead Door Corporation.
 - 1. Door Assembly: Insulated steel door assembly with rabbeted meeting rails to provide full-width interlocking structural rigidity.
 - a. Panel Thickness: 2 inches.
 - b. Exterior Surface: Flush.
 - c. Exterior Steel: 16 gauge, hot-dip galvanized.
 - d. Back Cover:
 - 1) 26 gauge steel.
 - e. Spring Counterbalance: Sized to weight of the door, with a helically wound, oil tempered torsion spring mounted on a steel shaft; cable drum of diecast aluminum with high strength galvanized aircraft cable. Sized with a minimum 7 to 1 safety factor.
 - 1) High cycle spring: 25,000 cycles.
 - f. Insulation: Polystyrene. Calculated R-value of 7.35.
 - 2. Finish and Color: Two coat baked-on polyester with white exterior and white interior color.
 - 3. Wind Load Design: Design as calculated in accordance with applicable code as follows:
 - 4. Hardware: Galvanized steel hinges and fixtures. Ball bearing rollers with hardened steel races.
 - 5. Lock:
 - a. Interior mounted slide lock with interlock switch for automatic operator.
 - 6. Weatherstripping:
 - a. Flexible bulb-type strip at bottom section.
 - b. Flexible Jamb seals.
 - c. Flexible Header seal.
 - 7. Track: Provide track as recommended by manufacturer to suit loading required and clearances available.
 - a. Size: 2 inch.
 - b. Type: High lift to follow roof slope.
 - 1) High lift.
 - 8. Electric Motor Operation: Provide UL listed electric operator, size and type as recommended by manufacturer to move door in either direction at not less than 6 inches nor more than 1 foot per second. Operator shall meet UL 325/2010 requirements for continuous monitoring of safety devices.
 - a. Entrapment Protection:
 - 1) Electric sensing edge monitored to meet UL 325/2010.
 - 2) Photoelectric sensors monitored to meet UL 325/2010.
 - b. Operator Controls:
 - 1) Push-button operated control stations with open, close, and stop buttons.
 - 2) Surface mounting.
 - 3) Interior location.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until openings have been properly prepared.
- B. Verify wall openings are ready to receive work and opening dimensions and tolerances are within specified limits.

- C. Verify electric power is available and of correct characteristics.

3.02 PREPARATION

- A. Clean adjacent surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Install overhead doors and track in accordance with approved shop drawings and the manufacturer's printed instructions.
- B. Coordinate installation with adjacent work to ensure proper clearances and allow for maintenance.
- C. Anchor assembly to wall construction and building framing without distortion or stress.
- D. Securely brace door tracks suspended from structure. Secure tracks to structural members only.
- E. Fit and align door assembly including hardware.
- F. Coordinate installation of electrical service. Complete power and control wiring from disconnect to unit components.

3.04 CLEANING AND ADJUSTING

- A. Adjust door assembly to smooth operation and in full contact with weatherstripping.
- B. Clean doors, frames, glass, and polycarbonate according to manufacturer's instructions.
- C. Remove temporary labels and visible markings. Do not remove polycarbonate care and maintenance label required to maintain warranty.

3.05 PROTECTION

- A. Do not permit construction traffic through overhead door openings after adjustment and cleaning.
- B. Protect installed products until completion of project.
- C. Touch-up, damaged coatings and finishes and repair minor damage before Substantial Completion.

END OF SECTION

**SECTION 08 43 13
ALUMINUM-FRAMED STOREFRONTS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Aluminum-framed storefront, with vision glass.
- B. Aluminum doors.
- C. Weatherstripping.
- D. Door hardware.

1.02 REFERENCE STANDARDS

- A. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site.
- B. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
- C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
- D. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- F. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
- G. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- H. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- I. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic).

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of other components that comprise the exterior enclosure.

1.04 SUBMITTALS

- A. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, and internal drainage details.
- B. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.
- C. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.
- D. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.
- G. Specimen warranty.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Handle products of this section in accordance with AAMA CW-10.
- B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.07 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.08 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.

PART 2 PRODUCTS**2.01 ALUMINUM-FRAMED STOREFRONT**

- A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - 1. Glazing Rabbet: For 1 inch insulating glazing.
 - 2. Glazing Rabbet: For 1/4 inch monolithic glazing.
 - 3. Glazing Position: Centered (front to back).
 - 4. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.
 - 5. Finish: Class I natural anodized.
 - a. Factory finish all surfaces that will be exposed in completed assemblies.
 - b. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.
 - 6. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 - 7. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
 - 8. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
 - 9. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
 - 10. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
 - 11. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
- B. Performance Requirements
 - 1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
 - a. Design Wind Loads: Comply with requirements of ASCE 7.
 - b. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
 - 2. Air Leakage: 0.06 cfm/sq ft maximum leakage of storefront wall area when tested in accordance with ASTM E283/E283M at 1.57 psf pressure difference.
 - 3. Overall U-value Including Glazing: 0.36 Btu/(hr sq ft deg F), maximum.

2.02 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, drainage holes and internal weep drainage system.
 - 1. Framing members for interior applications need not be thermally broken.
 - 2. Glazing Stops: Flush.
- B. Glazing: See Section 08 80 00 - Glazing.

2.03 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Sheet Aluminum: ASTM B209/B209M.
- C. Fasteners: Stainless steel.
- D. Exposed Flashings: Aluminum sheet, 20 gauge, 0.032 inch minimum thickness; finish to match framing members.
- E. Concealed Flashings: Galvanized steel, 26 gauge, 0.0179 inch minimum base metal thickness.
- F. Sealant for Setting Thresholds: Non-curing butyl type.
- G. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.
- H. Glazing Accessories: See Section 08 80 00.
- I. Touch-Up Primer for Galvanized Steel Surfaces: SSPC-Paint 20, zinc rich.

2.04 FINISHES

- A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.

2.05 HARDWARE

- A. Weatherstripping: Wool pile, continuous and replaceable; provide on all doors.
- B. Sill Sweep Strips: Resilient seal type, of neoprene; provide on all doors.
- C. Threshold: Extruded aluminum, one piece per door opening, ribbed surface; provide on all doors.
- D. Pivots: Center type; top and bottom.
 - 1. Provide on all doors.
- E. Exit Devices: Panic type.
 - 1. Provide on all doors.
- F. Door Closers: Exposed overhead.
 - 1. Provide on all doors.
- G. Handle Latch: Accessible type.
 - 1. Provide on all doors.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify dimensions, tolerances, and method of attachment with other work.
- B. Verify that storefront wall openings and adjoining water-resistive and/or air barrier seal materials are ready to receive work of this section.

3.02 INSTALLATION

- A. Install wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.

- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
- H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- I. Set thresholds in bed of sealant and secure.
- J. Install hardware using templates provided.
- K. Install glass using glazing method required to achieve performance criteria; see Section 08 80 00.
- L. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

- A. Maximum Variation from Plumb: 0.06 inch per 3 feet non-cumulative or 0.06 inch per 10 feet, whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.04 ADJUSTING

- A. Adjust operating hardware for smooth operation.

3.05 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.

3.06 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION

**SECTION 08 71 00
DOOR HARDWARE****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Hardware for wood and hollow metal doors.
- B. Hardware for fire-rated doors.
- C. Electrically operated and controlled hardware.
- D. Lock cylinders for doors that hardware is specified in other sections.
- E. Thresholds.
- F. Weatherstripping and gasketing.

1.02 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design.
- B. BHMA (CPD) - Certified Products Directory.
- C. BHMA A156.1 - Standard for Butts and Hinges.
- D. BHMA A156.2 - Bored and Preamsembled Locks and Latches.
- E. BHMA A156.3 - Exit Devices.
- F. BHMA A156.4 - Door Closers and Pivots.
- G. BHMA A156.5 - Cylinders and Input Devices for Locks.
- H. BHMA A156.6 - Standard for Architectural Door Trim.
- I. BHMA A156.7 - Template Hinge Dimensions.
- J. BHMA A156.16 - Standard for Auxiliary Hardware.
- K. BHMA A156.18 - Materials and Finishes.
- L. BHMA A156.21 - Thresholds.
- M. BHMA A156.22 - Standard for Gasketing.
- N. BHMA A156.115 - Hardware Preparation in Steel Doors and Steel Frames.
- O. BHMA A156.115W - Hardware Preparation in Wood Doors with Wood or Steel Frames.
- P. DHI (H&S) - Sequence and Format for the Hardware Schedule.
- Q. DHI (LOCS) - Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.
- R. DHI WDHS.3 - Recommended Locations for Architectural Hardware for Flush Wood Doors.
- S. ICC A117.1 - Accessible and Usable Buildings and Facilities.
- T. NFPA 70 - National Electrical Code.
- U. NFPA 80 - Standard for Fire Doors and Other Opening Protectives.
- V. NFPA 101 - Life Safety Code.
- W. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.
- X. UL (DIR) - Online Certifications Directory.
- Y. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the manufacture, fabrication, and installation of products that door hardware is installed on.
- B. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

- C. Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.

1.04 SUBMITTALS

- A. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project, and includes construction details, material descriptions, finishes, and dimensions and profiles of individual components.
- B. Shop Drawings - Door Hardware Schedule: Submit detailed listing that includes each item of hardware to be installed on each door. Use door numbering scheme as included in Contract Documents.
 - 1. Prepared by or under supervision of Architectural Hardware Consultant (AHC).
 - 2. Comply with DHI (H&S) using door numbers and hardware set numbers as indicated in construction documents.
 - 3. List groups and suffixes in proper sequence.
 - 4. Provide complete description for each door listed.
 - 5. Provide manufacturer name, product names, and catalog numbers; include functions, types, styles, sizes and finishes of each item.
 - 6. Include account of abbreviations and symbols used in schedule.
- C. Shop Drawings - Electrified Door Hardware: Submit diagrams for power, signal, and control wiring for electrified door hardware that include details of interface with building safety and security systems. Provide elevations and diagrams for each electrified door opening as follows:
 - 1. Prepared by or under supervision of Architectural Hardware Consultant (AHC) and Electrified Hardware Consultant (EHC).
 - 2. Elevations: Submit front and back elevations of each door opening showing electrified devices with connections installed and an operations narrative describing how opening operates from either side at any given time.
 - 3. Diagrams: Submit point-to-point wiring diagram that shows each device in door opening system with related colored wire connections to each device.
- D. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.
- G. Specimen warranty.
- H. Project Record Documents: Record actual locations of concealed equipment, services, and conduit.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified for commercial door hardware with at least three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Package hardware items individually; label and identify each package with door opening code to match door hardware schedule.

1.07 WARRANTY

- A. Manufacturer's Warranty: Provide warranty against defects in material and workmanship for period indicated. Complete forms in Government's name and register with manufacturer.
 - 1. Closers: Five years, minimum.
 - 2. Exit Devices: Three years, minimum.
 - 3. Locksets and Cylinders: Three years, minimum.
 - 4. Other Hardware: Two years, minimum.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

- A. Provide specified door hardware as required to make doors fully functional, compliant with applicable codes, and secure to extent indicated.
- B. Provide individual items of single type, of same model, and by same manufacturer.
- C. Provide door hardware products that comply with the following requirements:
 - 1. Applicable provisions of federal, state, and local codes.
 - 2. Accessibility: ADA Standards and ICC A117.1.
 - 3. Applicable provisions of NFPA 101.
 - 4. Fire-Rated Doors: NFPA 80, listed and labeled by qualified testing agency for fire protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
 - 5. Hardware on Fire-Rated Doors: Listed and classified by UL (DIR) or testing firm acceptable to authorities having jurisdiction as suitable for application indicated.
 - 6. Listed and certified compliant with specified standards by BHMA (CPD).
 - 7. Hardware Preparation for Steel Doors and Steel Frames: BHMA A156.115.
 - 8. Hardware Preparation for Wood Doors with Wood or Steel Frames: BHMA A156.115W.
 - 9. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified.
- D. Electrically Operated and/or Controlled Hardware: Provide necessary power supplies, power transfer hinges, relays, and interfaces as required for proper operation; provide wiring between hardware and control components and to building power connection in compliance with NFPA 70.
 - 1. See Division 27 for additional access control system requirements.
- E. Lock Function: Provide lock and latch function numbers and descriptions of manufacturer's series. See Door Hardware Schedule.
- F. Fasteners:
 - 1. Provide fasteners of proper type, size, quantity, and finish that comply with commercially recognized standards for proposed applications.
 - a. Aluminum fasteners are not permitted.
 - b. Provide phillips flat-head screws with heads finished to match door surface hardware unless otherwise indicated.
 - 2. Provide machine screws for attachment to reinforced hollow metal and aluminum frames.
 - a. Self-drilling (Tek) type screws are not permitted.
 - 3. Provide stainless steel machine screws and lead expansion shields for concrete and masonry substrates.
 - 4. Fire-Rated Applications: Comply with NFPA 80.
 - a. Provide wood or machine screws for hinges mortised to doors or frames, strike plates to frames, and closers to doors and frames.
 - b. Provide steel through bolts for attachment of surface mounted closers, hinges, or exit devices to door panels unless proper door blocking is provided.
 - 5. Concealed Fasteners: Do not use through or sex bolt type fasteners on door panel sides indicated as concealed fastener locations, unless otherwise indicated.

2.02 HINGES

- A. Hinges: Comply with BHMA A156.1, Grade 1.
 - 1. Butt Hinges: Comply with BHMA A156.1 and BHMA A156.7 for templated hinges.
 - a. Provide hinge width required to clear surrounding trim.
 - 2. Provide hinges on every swinging door.
 - 3. Provide five-knuckle full mortise butt hinges unless otherwise indicated.
 - 4. Provide ball-bearing hinges at each door with closer.
 - 5. Provide non-removable pins on exterior outswinging doors.

6. Provide power transfer hinges where electrified hardware is mounted in door leaf.
7. Provide following quantity of butt hinges for each door:
 - a. Doors up to 60 inches High: Two hinges.
 - b. Doors From 60 inches High up to 90 inches High: Three hinges.
 - c. Doors 90 inches High up to 120 inches High: Four hinges.

2.03 FLUSH BOLTS

- A. Flush Bolts: Comply with BHMA A156.16, Grade 1.
 1. Flush Bolt Throw: 3/4 inch, minimum.
 2. Provides extension bolts in leading edge of door, one bolt into floor, one bolt into top of frame.
 - a. Pairs of Swing Doors: At inactive leaves, provide flush bolts of type as required to comply with code.
 3. Provide dustproof floor strike for bolt into floor, except at metal thresholds.

2.04 EXIT DEVICES

- A. Exit Devices: Comply with BHMA A156.3, Grade 1.
 1. Lever design to match lockset trim.
 2. Provide cylinder with cylinder dogging or locking trim.
 3. Provide exit devices properly sized for door width and height.
 4. Provide strike as recommended by manufacturer for application indicated.
 5. Provide UL (DIR) listed exit device assemblies for fire-rated doors and panic device assemblies for non-fire-rated doors.

2.05 LOCK CYLINDERS

- A. Manufacturers:
 1. BEST, dormakaba Group: www.bestaccess.com/#sle.
 2. No substitutions permitted.
- B. Lock Cylinders: Provide key access on outside of each lock, unless otherwise indicated.
 1. Provide standard and full size interchangeable core (FSIC) type cylinders, Grade 1, with six-pin core in compliance with BHMA A156.5 at locations indicated.
 2. Provide cams and/or tailpieces as required for locking devices.
 3. Within specific Door Sections, when provisions for lock cylinder are being referenced to this Section, provide specified lock cylinder and keyed to building keying system, unless otherwise indicated.

2.06 CYLINDRICAL LOCKS

- A. Cylindrical Locks (Bored): Comply with BHMA A156.2, Grade 1, 4000 Series.
 1. Bored Hole: 2-1/8 inch diameter.
 2. Latchbolt Throw: 1/2 inch, minimum.
 3. Backset: 2-3/4 inch unless otherwise indicated.
 4. Strikes: Provide manufacturer's standard strike for each latchset or lockset with strike box and curved lip extending to protect frame in compliance with indicated requirements.
 - a. Finish: To match lock or latch.
 - b. Rabbet Front and Strike: Provide on locksets for use with rabbeted meeting rails.
 5. Provide a lock for each door, unless otherwise indicated that lock is not required.
 6. Provide an office lockset for swinging door where hardware set is not indicated.
 7. Trim: Provide lever handle or pull trim on outside of each lock, unless otherwise indicated.

2.07 DOOR PULLS AND PUSH PLATES

- A. Door Pulls and Push Plates: Comply with BHMA A156.6.
 1. Pull Type: Straight, unless otherwise indicated.
 2. Push Plate Type: Flat, with square corners, unless otherwise indicated.
 - a. Edges: Beveled, unless otherwise indicated.
 3. Material: Aluminum, unless otherwise indicated.

4. On solid doors, provide matching door pull and push plate on opposite faces.

2.08 CLOSERS

- A. Closers: Comply with BHMA A156.4, Grade 1.
 1. Type: Surface mounted to door.
 2. Provide door closer on each exterior door.
 3. Provide door closer on each fire-rated and smoke-rated door.
 - a. Spring hinges are not an acceptable self-closing device, unless otherwise indicated.
 4. At corridor entry doors, mount closer on room side of door.
 5. At outswinging exterior doors, mount closer on interior side of door.

2.09 KICK PLATES

- A. Kick Plates: Provide along bottom edge of push side of every door with closer, except aluminum storefront and glass entry doors, unless otherwise indicated.
 1. Size: 8 inch high by 2 inch less door width (LDW) on push side of door.

2.10 WALL STOPS

- A. Wall Stops: Comply with BHMA A156.16, Grade 1 and Resilient Material Retention Test as described in this standard.
 1. Provide wall stops to prevent damage to wall surface upon opening door.
 2. Type: Bumper, concave, wall stop.
 3. Material: Aluminum housing with rubber insert.

2.11 THRESHOLDS

- A. Thresholds: Comply with BHMA A156.21.
 1. Provide threshold at each exterior door, unless otherwise indicated.
 2. Type: Rabbeted with door stop.
 3. Material: Aluminum.
 4. Threshold Surface: Fluted horizontal grooves across full width.
 5. Field cut threshold to profile of frame and width of door sill for tight fit.
 6. Provide non-corroding fasteners at exterior locations.

2.12 WEATHERSTRIPPING AND GASKETING

- A. Weatherstripping and Gasketing: Comply with BHMA A156.22.
 1. Head and Jamb Type: Adjustable.
 2. Door Sweep Type: Encased in retainer.
 3. Material: Aluminum, with brush weatherstripping.
 4. Provide weatherstripping on each exterior door at head, jambs, and meeting stiles of door pairs, unless otherwise indicated.
 5. Provide door bottom sweep on each exterior door, unless otherwise indicated.

2.13 FINISHES

- A. Finishes: Provide door hardware of same finish, unless otherwise indicated.
 1. Primary Finish: 626; satin chromium plated over nickel, with brass or bronze base material (former US equivalent US26D); BHMA A156.18.
 2. Exceptions:
 - a. Where base material metal is specified to be different, provide finish that is an equivalent appearance in accordance with BHMA A156.18.
 - b. Hinges for Fire-Rated Doors: Steel base material with painted finish, in compliance with NFPA 80.
 - c. Door Closer Covers and Arms: Color as selected by Contracting Officer or Contracting Officer's Representative from manufacturer's standard colors unless otherwise indicated.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that doors and frames are ready to receive this work; labeled, fire-rated doors and frames are properly installed, and dimensions are as indicated on shop drawings.
- B. Verify that electric power is available to power operated devices and of correct characteristics.

3.02 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions and applicable codes.
- B. Install hardware on fire-rated doors and frames in accordance with applicable codes and NFPA 80.
- C. Use templates provided by hardware item manufacturer.
- D. Do not install surface mounted items until application of finishes to substrate are fully completed.
- E. Door Hardware Mounting Heights: Distance from finished floor to center line of hardware item. As indicated in following list, unless noted otherwise on drawings.
 - 1. For Steel Doors and Frames: Install in compliance with DHI (LOCS) recommendations.
 - 2. For Wood Doors: Install in compliance with DHI WDHS.3 recommendations.
 - 3. Mounting heights in compliance with ADA Standards:
 - a. Locksets: 40-5/16 inch.
 - b. Push Plates/Pull Bars: 42 inch.
 - c. Deadlocks (Deadbolts): 48 inch.
 - d. Exit Devices: 40-5/16 inch.
- F. Set exterior door thresholds with full-width bead of elastomeric sealant at each point of contact with floor providing a continuous weather seal; anchor thresholds with stainless steel countersunk screws.

3.03 FIELD QUALITY CONTROL

- A. Perform field inspection and testing under provisions of Section 01 40 00 - Quality Requirements.

3.04 ADJUSTING

- A. Adjust work under provisions of Section 01 77 00-Closeout Procedures.
- B. Adjust hardware for smooth operation.
- C. Adjust gasketing for complete, continuous seal; replace if unable to make complete seal.

3.05 CLEANING

- A. Clean finished hardware in accordance with manufacturer's written instructions after final adjustments have been made.
- B. Clean adjacent surfaces soiled by hardware installation.
- C. Replace items that cannot be cleaned to manufacturer's level of finish quality at no additional cost.

3.06 PROTECTION

- A. Protect finished Work under provisions of Section 01 77 00-Closeout Procedures.
- B. Do not permit adjacent work to damage hardware or finish.

END OF SECTION

**SECTION 08 80 00
GLAZING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Insulating glass units.
- B. Glazing compounds.

1.02 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.
- B. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.
- C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
- D. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
- E. ASTM C1036 - Standard Specification for Flat Glass.
- F. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
- G. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass.
- H. ASTM C1193 - Standard Guide for Use of Joint Sealants.
- I. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass.
- J. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings.
- K. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation.
- L. GANA (SM) - GANA Sealant Manual.
- M. NFRC 100 - Procedure for Determining Fenestration Product U-factors.
- N. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
- O. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems.

1.03 SUBMITTALS

- A. Product Data on Insulating Glass Unit Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- B. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- C. Samples: Submit two samples 4 by 6 inch in size of glass units.
- D. Certificate: Certify that products of this section meet or exceed specified requirements.
- E. Manufacturer's qualification statement.
- F. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Government's name and registered with manufacturer.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience.

1.05 FIELD CONDITIONS

- A. Do not install glazing when ambient temperature is less than 40 degrees F.
- B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.06 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Insulating Glass Units: Provide a five (5) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.
- C. Laminated Glass: Provide a five (5) year manufacturer warranty to include coverage for delamination, including providing products to replace failed units.

PART 2 PRODUCTS**2.01 PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES**

- A. Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.
 - 1. Design Pressure: Calculated in accordance with ASCE 7.
 - 2. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
 - 3. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
 - 4. Glass thicknesses listed are minimum.
- B. Weather-Resistive Barrier Seals: Provide completed assemblies that maintain continuity of building enclosure water-resistive barrier, vapor retarder, and/or air barrier.
- C. Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:
 - 1. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 7 computer program.
 - 2. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 7 computer program.
 - 3. Solar Optical Properties: Comply with NFRC 300 test method.

2.02 GLASS MATERIALS

- A. Float Glass: Provide float glass based glazing unless otherwise indicated.
 - 1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality - Q3.
 - 2. Kind FT - Fully Tempered Type: Complies with ASTM C1048.
- B. Laminated Glass: Float glass laminated in accordance with ASTM C1172.
 - 1. Laminated Safety Glass: Complies with ANSI Z97.1 - Class B or 16 CFR 1201 - Category I impact test requirements.
 - 2. Polyvinyl Butyral (PVB) Interlayer: 0.030 inch thick, minimum.

2.03 INSULATING GLASS UNITS

- A. Fabricator: Certified by glass manufacturer for type of glass, coating, and treatment involved and capable of providing specified warranty.
- B. Insulating Glass Units: Types as indicated.
 - 1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
 - 2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
 - 3. Metal-Edge Spacers: Aluminum, bent and soldered corners.
 - 4. Spacer Color: Black.

5. Edge Seal:
 - a. Single-Sealed System: Provide silicone, polysulfide, or polyurethane sealant as seal applied around perimeter.
 - b. Color: Black.
6. Purge interpane space with dry air, hermetically sealed.
7. Pre-Equalized Insulated Glazing Units: Provide glazing units sealed at manufacturing plant with internal pressure matching pressure of the installation location.
- C. Type IG - Insulating Glass Units: Vision glass, double glazed.
 1. Applications: Exterior glazing unless otherwise indicated.
 2. Space between lites filled with air.
 3. Outboard Lite: Laminated, 1/4 inch thick, minimum.
 - a. Tint: Clear.
 - b. Coating: Low-E (passive type), on #2 surface.
 4. Inboard Lite: Annealed float glass, 1/4 inch thick, minimum.
 - a. Tint: Clear.
 5. Total Thickness: 1 inch.
 6. Thermal Transmittance (U-Value), Summer - Center of Glass: 0.36, nominal.
 7. Visible Light Transmittance (VLT): 70 percent, nominal.
 8. Solar Heat Gain Coefficient (SHGC): 0.36, nominal.
 9. Glazing Method: Dry glazing method, gasket glazing.

2.04 ACCESSORIES

- A. Setting Blocks: Silicone, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot of glazing or minimum 4 inch by width of glazing rabbet space minus 1/16 inch by height to suit glazing method and pane weight and area.
- B. Glazing Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.

PART 3 EXECUTION

3.01 VERIFICATION OF CONDITIONS

- A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.
- B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.
- C. Verify that sealing between joints of glass framing members has been completed effectively.
- D. Proceed with glazing system installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean contact surfaces with appropriate solvent and wipe dry within maximum of 24 hours before glazing. Remove coatings that are not tightly bonded to substrates.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Prime surfaces scheduled to receive sealant where required for proper sealant adhesion.

3.03 INSTALLATION, GENERAL

- A. Install glazing in compliance with written instructions of glass, gaskets, and other glazing material manufacturers, unless more stringent requirements are indicated, including those in glazing referenced standards.
- B. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.

- C. Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.
- D. Set glass lites in proper orientation so that coatings face exterior or interior as indicated.
- E. Prevent glass from contact with any contaminating substances that may be the result of construction operations such as, and not limited to the following; weld splatter, fire-safing, plastering, mortar droppings, and paint.

3.04 INSTALLATION - DRY GLAZING METHOD (GASKET GLAZING)

- A. Application - Exterior and/or Interior Glazed: Set glazing infills from either the exterior or the interior of the building.
- B. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
- C. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.
- D. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.05 CLEANING

- A. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
- B. Remove nonpermanent labels immediately after glazing installation is complete.
- C. Clean glass and adjacent surfaces after sealants are fully cured.
- D. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

3.06 PROTECTION

- A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.
- B. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

END OF SECTION

**SECTION 08 91 00
LOUVERS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Louvers, frames, and accessories.

1.02 REFERENCE STANDARDS

- A. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).
- B. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating.
- C. AMCA 511 - Certified Ratings Program Product Rating Manual for Air Control Devices.

1.03 SUBMITTALS

- A. Product Data: Provide data describing design characteristics, maximum recommended air velocity, design free area, materials and finishes.
- B. Shop Drawings: Indicate louver layout plan and elevations, opening and clearance dimensions, and tolerances; head, jamb and sill details; blade configuration, screens, blank-off areas required, and frames.
- C. Samples: Submit two samples 2 by 2 inches in size illustrating finish and color of exterior and interior surfaces.
- D. Test Reports: Independent agency reports showing compliance with specified performance criteria.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.

1.05 WARRANTY

- A. Provide five year manufacturer's warranty against distortion, metal degradation, and connection failures of louver components.
 - 1. Finish: Include twenty year coverage against degradation of exterior finish.

PART 2 PRODUCTS**2.01 LOUVERS**

- A. Louvers: Factory fabricated and assembled, complete with frame, mullions, and accessories; AMCA Certified in accordance with AMCA 511.
 - 1. Wind Load Resistance: Design to resist positive and negative wind load of 25 psf without damage or permanent deformation.
 - 2. Intake Louvers: Design to allow maximum of 0.01 oz/sq ft water penetration at calculated intake design velocity based on design air flow and actual free area, when tested in accordance with AMCA 500-L.
 - 3. Screens: Provide bird screens at all louvers.
- B. Stationary Louvers: Horizontal blade, extruded aluminum construction.
 - 1. Blades: Straight.
 - 2. Frame: 4 inches deep, channel profile; corner joints mitered and , with continuous recessed caulking channel each side.
 - 3. Aluminum Thickness: Frame 12 gauge, 0.0808 inch minimum; blades 12 gauge, 0.0808 inch minimum.
 - 4. Aluminum Finish: High performance powder coatings; finish welded units after fabrication.

2.02 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).

2.03 FINISHES

- A. High Performance Organic Coating: Primer and topcoat coatings system based on polyester resin powder containing high-level of isophthalic acid; with minimum dry film thickness (DFT) of 2 to 3.5 mil, 0.0020 to 0.0035 inch over aluminum extrusions and panels; meeting requirements of AAMA 2604.

2.04 ACCESSORIES

- A. Blank-Off Panels: Same material as louver, painted black on exterior side; provide where duct connected to louver is smaller than louver frame, sealing off louver area outside duct.
- B. Bird Screen: Interwoven wire mesh of steel, 14 gauge, 0.0641 inch diameter wire, 1/2 inch open weave, diagonal design.
- C. Fasteners and Anchors: Galvanized steel.
- D. Flashings: Of same material as louver frame, formed to required shape, single length in one piece per location.
- E. Sealant for Setting Sills and Sill Flashing: Non-curing butyl type.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that prepared openings and flashings are ready to receive this work and opening dimensions are as indicated on shop drawings.
- B. Verify that field measurements are as indicated.

3.02 INSTALLATION

- A. Install louver assembly in accordance with manufacturer's instructions.
- B. Install louvers level and plumb.
- C. Set sill members and sill flashing in continuous bead of sealant.
- D. Install flashings and align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
- E. Secure louver frames in openings with concealed fasteners.
- F. Coordinate with installation of mechanical ductwork.

3.03 CLEANING

- A. Strip protective finish coverings.
- B. Clean surfaces and components.

END OF SECTION

**SECTION 09 21 16
GYPSUM BOARD ASSEMBLIES**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Performance criteria for gypsum board assemblies.
- B. Metal stud wall framing.
- C. Metal channel ceiling framing.
- D. Acoustic insulation.
- E. Cementitious backing board.
- F. Gypsum wallboard.
- G. Joint treatment and accessories.

1.02 REFERENCE STANDARDS

- A. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members.
- B. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing.
- C. AISI S240 - North American Standard for Cold-Formed Steel Structural Framing.
- D. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- F. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.
- G. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.
- H. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
- I. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- J. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
- K. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board.
- L. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
- M. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- N. ASTM C1047 - Standard Specification for Accessories For Gypsum Wallboard and Gypsum Veneer Base.
- O. ASTM C1396/C1396M - Standard Specification for Gypsum Board.
- P. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
- Q. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- R. ASTM E413 - Classification for Rating Sound Insulation.
- S. GA-216 - Application and Finishing of Gypsum Panel Products.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of gypsum board assemblies with size, location, and installation of service utilities.

1.04 SUBMITTALS

- A. Product Data:
 - 1. Provide data on metal framing, gypsum board, accessories, and joint finishing system.
 - 2. Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.
- B. Shop Drawings: Indicate special details associated with acoustic seals.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store gypsum products and accessories indoors and keep above freezing. Elevate boards above floor, on nonwicking supports, in accordance with manufacturer's recommendations.
- B. Store metal products to prevent corrosion.

PART 2 PRODUCTS**2.01 GYPSUM BOARD ASSEMBLIES**

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
 - 1. See PART 3 for finishing requirements.
- B. Interior Partitions, Indicated as Acoustic: Provide completed assemblies with the following characteristics:
 - 1. Acoustic Attenuation: STC of 45-49 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

2.02 METAL FRAMING MATERIALS

- A. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S220 or equivalent.
 - 1. Corrosion Protection Coating Designation: G40, or equivalent in accordance with AISI S220.
- B. Nonstructural Framing System Components: AISI S220; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/120 at 5 psf.
 - 1. Studs: C-shaped with knurled or embossed faces.
 - 2. Runners: U shaped, sized to match studs.
 - 3. Ceiling Channels: C-shaped.
 - 4. Furring Members: Hat-shaped sections, minimum depth of 7/8 inch.
- C. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection and prevent rotation of studs while maintaining structural performance of partition.
 - 1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI S100.
 - 2. Material: ASTM A653/A653M steel sheet, SS Grade 50/340, with G60/Z180 hot-dipped galvanized coating.
 - 3. Provide top track preassembled with connection devices spaced to fit stud spacing indicated on drawings; minimum track length of 12 feet.
- D. Non-structural Framing Accessories:
 - 1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
 - 2. Framing Connectors: ASTM A653/A653M G90 galvanized steel clips; secures cold rolled channel to wall studs for lateral bracing.
- E. Grid Suspension Systems: Steel grid system of main tees and support bars connected to structure using hanging wire.

2.03 BOARD MATERIALS

- A. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 - 1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 - 2. Thickness:
 - a. Vertical Surfaces: 5/8 inch.
 - b. Ceilings: 1/2 inch.
- B. Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.
 - 1. Application: Vertical surfaces behind thinset tile, except in wet areas.
 - 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 3. Regular Board Thickness: 5/8 inch.
 - 4. Edges: Tapered.

2.04 GYPSUM BOARD ACCESSORIES

- A. Acoustic Insulation: ASTM C665; preformed mineral-fiber, friction fit type, unfaced; thickness 2 inches.
- B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
- C. Beads, Joint Accessories, and Other Trim: ASTM C1047, rigid plastic, galvanized steel, or rolled zinc, unless noted otherwise.
 - 1. Corner Beads: Low profile, for 90 degree outside corners.
 - 2. Expansion Joints:
 - a. Type: V-shaped PVC with tear away fins.
- D. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
 - 1. Paper Tape: 2 inch wide, creased paper tape for joints and corners.
 - 2. Joint Compound: Drying type, vinyl-based, ready-mixed.
- E. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.
- F. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws, corrosion-resistant.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that project conditions are appropriate for work of this section to commence.

3.02 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C1007/AISI S220 and manufacturer's instructions.
- B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
 - 1. Level ceiling system to a tolerance of 1/1200.
- C. Studs: Space studs at 16 inches on center.
 - 1. Extend partition framing 12 inches above ceiling, minimum unless noted otherwise on the drawings.
 - 2. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.

- D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.

3.03 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Acoustic Sealant: Install in accordance with manufacturer's instructions.
 - 1. Place one bead continuously on substrate before installation of perimeter framing members.
 - 2. Seal around all penetrations by conduit, pipe, ducts, and rough-in boxes, except where firestopping is provided.

3.04 BOARD INSTALLATION

- A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Single-Layer Nonrated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.
- C. Double-Layer, Nonrated: Use gypsum board for first layer, placed parallel to framing or furring members, with ends and edges occurring over firm bearing. Use glass mat faced gypsum board at exterior walls and at other locations as indicated. Place second layer perpendicular to framing or furring members. Offset joints of second layer from joints of first layer.
- D. Cementitious Backing Board: Install over steel framing members where indicated, in accordance with ANSI A108.11 and manufacturer's instructions.
- E. Installation on Metal Framing: Use screws for attachment of gypsum board except face layer of nonrated double-layer assemblies, which may be installed by means of adhesive lamination.

3.05 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
 - 1. Not more than 30 feet apart on walls and ceilings over 50 feet long.
- B. Corner Beads: Install at external corners, using longest practical lengths.
- C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

3.06 JOINT TREATMENT

- A. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.
- B. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 - 1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
 - 2. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
 - 3. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.
 - 4. Level 0: Temporary partitions.
- C. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch.
 - 2. Taping, filling, and sanding are not required at surfaces behind adhesive applied ceramic tile and fixed cabinetry.
 - 3. Taping, filling, and sanding are not required at base layer of double-layer applications.
- D. Fill and finish joints and corners of cementitious backing board as recommended by manufacturer.

3.07 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

3.08 PROTECTION

- A. Protect installed gypsum board assemblies from subsequent construction operations.

END OF SECTION

**SECTION 09 30 00
TILING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Tile for floor applications.
- B. Tile for wall applications.
- C. Cementitious backer board as tile substrate.
- D. Non-ceramic trim.

1.02 REFERENCE STANDARDS

- A. ANSI A108/A118/A136 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium).
- B. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units.
- C. ANSI A118.4 - American National Standard Specifications for Modified Dry-Set Cement Mortar.
- D. ANSI A118.6 - American National Standard Specifications for Standard Cement Grouts for Tile Installation.
- E. ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units.
- F. ANSI A118.12 - American National Standard Specifications for Crack Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation.
- G. ANSI A137.1 - American National Standard Specifications for Ceramic Tile.
- H. ASTM C373 - Standard Test Methods for Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products.
- I. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
- J. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
- K. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation.
- L. TCNA (HB-GP) - Handbook for Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs Installation.

1.03 SUBMITTALS

- A. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
- B. Shop Drawings: Indicate tile layout, patterns, perimeter conditions, junctions with dissimilar materials, control and expansion joints, ceramic accessories, and setting details.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum five years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.06 FIELD CONDITIONS

- A. Maintain ambient and substrate temperature above 50 degrees F and below 100 degrees F during installation and curing of setting materials.

PART 2 PRODUCTS**2.01 TILE**

- A. Glazed Wall Tile: ANSI A137.1 standard grade.
 - 1. Moisture Absorption: 7.0 to 20.0 percent as tested in accordance with ASTM C373.
 - 2. Size: 4-1/4 by 4-1/4 inch, nominal.
 - 3. Edges: Cushioned.
 - 4. Surface Finish: Matte glaze.
 - 5. Color: As selected by Contracting Officer or Contracting Officer's Representative from manufacturer's standard range.
 - 6. Trim Units: Matching bead, bullnose, cove, and base shapes in sizes coordinated with field tile.
- B. Porcelain Tile: ANSI A137.1 standard grade.
 - 1. Moisture Absorption: 0 to 0.5 percent as tested in accordance with ASTM C373.
 - 2. Size: 6 by 6 inch, nominal.
 - 3. Thickness: 3/8 inch.
 - 4. Edges: Square.
 - 5. Surface Finish: Unglazed.
 - 6. Color: As selected by Contracting Officer or Contracting Officer's Representative from manufacturer's standard range.
 - 7. Trim Units: Matching bullnose, cove base, and cove shapes in sizes coordinated with field tile.

2.02 TRIM AND ACCESSORIES

- A. Non-Ceramic Trim: Satin natural anodized extruded aluminum, style and dimensions to suit application, set with tile mortar or adhesive.
 - 1. Applications:
 - a. Open edges of wall tile.
 - b. Thresholds at door openings.
 - c. Floor and wall expansion and control joints.

2.03 SETTING MATERIALS

- A. Provide setting and grout materials from same manufacturer.
- B. Latex-Portland Cement Mortar Bond Coat: ANSI A118.4.
- C. Mortar Bed Materials: Pre-packaged mix of Portland cement, sand, latex additive, and water.

2.04 GROUTS

- A. Provide setting and grout materials from same manufacturer.
- B. Standard Grout: ANSI A118.6 standard cement grout.
 - 1. Applications: Use where indicated on drawings and where no other type of grout is indicated.
 - 2. Use sanded grout for joints 1/8 inch wide and larger; use unsanded grout for joints less than 1/8 inch wide.
 - 3. Color: As selected by Contracting Officer or Contracting Officer's Representative from manufacturer's full line.

2.05 MAINTENANCE MATERIALS

- A. Tile Sealant: Gunnable, silicone, siliconized acrylic, or urethane sealant; moisture and mildew resistant type.
 - 1. Applications: Between tile and plumbing fixtures.
 - 2. Color: match adjacent surface color.

2.06 ACCESSORY MATERIALS

- A. Concrete Floor Slab Crack Isolation Membrane: Material complying with ANSI A118.12; not intended as waterproofing.
 - 1. Crack Resistance: No failure at 1/8 inch gap, minimum.
- B. Backer Board: Cementitious type complying with ANSI A118.9; high density, glass fiber reinforced, 7/16 inch thick; 2-inch wide coated glass fiber tape for joints and corners.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive tile.
- B. Verify wall surfaces are smooth and flat within tolerances specified for that type of work, are dust-free, and are ready to receive tile.
- C. Verify that subfloor surfaces are dust free and free of substances that could impair bonding of setting materials to subfloor surfaces.
- D. Cementitious Subfloor Surfaces: Verify that substrates are ready for tiling installation by testing for moisture and alkalinity (pH).
 - 1. Test as Follows:
 - a. Alkalinity (pH): ASTM F710.
 - b. Moisture Vapor Emission: ASTM F1869.
 - 2. Obtain instructions if test results are not within limits recommended by tiling material manufacturer and setting material manufacturer.
- E. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A. Vacuum clean surfaces and damp clean.
- B. Seal substrate surface cracks with filler.
- C. Install cementitious backer board in accordance with ANSI A108.11 and board manufacturer's instructions. Tape joints and corners, cover with skim coat of setting material to feather edge.
- D. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

3.03 INSTALLATION - GENERAL

- A. Install tile and grout in accordance with applicable requirements of ANSI A108/A118/A136, manufacturer's instructions, and TCNA (HB) or TCNA (HB-GP) recommendations, as applicable.
- B. Lay tile to pattern indicated on drawings. Do not interrupt tile pattern through openings.
- C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
- D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
- E. Form internal angles square and external angles bullnosed.
- F. Install non-ceramic trim in accordance with manufacturer's instructions.
- G. Sound tile after setting. Replace hollow sounding units.
- H. Keep control and expansion joints free of mortar, grout, and adhesive.
- I. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
- J. Grout tile joints unless otherwise indicated on drawings. Use standard grout unless otherwise indicated on drawings.

- K. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

3.04 INSTALLATION - FLOORS - THIN-SET METHODS

- A. Over interior concrete substrates, install in accordance with TCNA (HB) Method F113, dry-set or latex-Portland cement bond coat, on ground, with standard grout, unless otherwise indicated on drawings.
 - 1. Use uncoupling membrane under tile unless other underlayment is indicated on drawings.

3.05 INSTALLATION - WALL TILE

- A. Over cementitious backer units on studs, install in accordance with TCNA (HB) Method W244C, using membrane at toilet rooms.
- B. Over interior concrete and masonry, install in accordance with TCNA (HB) Method W202I, thin-set with dry-set or latex-Portland cement bond coat.

3.06 CLEANING

- A. Clean tile and grout surfaces.

3.07 PROTECTION

- A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION

**SECTION 09 51 00
ACOUSTICAL CEILINGS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Suspended metal grid ceiling system.
- B. Acoustical units.

1.02 REFERENCE STANDARDS

- A. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
- B. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
- C. ASTM E1264 - Standard Classification for Acoustical Ceiling Products.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Do not install acoustical units until after interior wet work is dry.

1.04 SUBMITTALS

- A. Shop Drawings: Indicate grid layout and related dimensioning.
- B. Product Data: Provide data on suspension system components and acoustical units.
- C. Samples: Submit two samples 4 by 4 inch in size illustrating material and finish of acoustical units.
- D. Manufacturer's qualification statement.

1.05 QUALITY ASSURANCE

- A. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.06 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS**2.01 ACOUSTICAL UNITS**

- A. Acoustical Panels, Type A: Painted mineral fiber, with the following characteristics:
 - 1. Classification: ASTM E1264 Type III.
 - a. Form: 2, water felted.
 - 2. Size: 24 by 24 inches.
 - 3. Thickness: 3/4 inch.
 - 4. Light Reflectance: 82 percent, determined in accordance with ASTM E1264.
 - 5. NRC Range: 0.60 to 0.70, determined in accordance with ASTM E1264.
 - 6. Ceiling Attenuation Class (CAC): 40, determined in accordance with ASTM E1264.
 - 7. Panel Edge: Square.
 - 8. Color: White.
 - 9. Suspension System: Exposed grid.
 - 10. Products:
 - a. Armstrong World Industries, Inc; Fine Fissured: www.armstrongceilings.com/#sle.

- b. Or approved equal.

2.02 SUSPENSION SYSTEM(S)

- A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.
- B. Exposed Suspension System: Hot-dip galvanized steel grid with steel cap.
 - 1. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
 - 2. Profile: Tee; 15/16 inch face width.
 - 3. Finish: Baked enamel.
 - 4. Color: White.
 - 5. Products:
 - a. Armstrong World Industries, Inc; Prelude XL: www.armstrongceilings.com/#sle.

2.03 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application and ceiling system flatness requirement specified.
- B. Hanger Wire: 12 gauge, 0.08 inch galvanized steel wire.
- C. Hold-Down Clips: Manufacturer's standard clips to suit application.
- D. Perimeter Moldings: Same metal and finish as grid.
 - 1. Size: As required for installation conditions.
 - 2. Angle Molding: L-shaped, for mounting at same elevation as face of grid.
- E. Metal Edge Trim for Suspension Systems: Steel or extruded aluminum; provide attachment clips, splice plates, and preformed corner pieces for complete trim system.
 - 1. Trim Height: 6 inches.
 - 2. Finish: Baked enamel.
 - 3. Color: White.
 - 4. Products:
 - a. Armstrong World Industries, Inc; AXIOM Classic: www.armstrongceilings.com/#sle.
 - b. USG Corporation; Compasso Suspension Trim: www.usg.com/ceilings/#sle.
 - c. Or approved equal.
- F. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.02 PREPARATION

- A. Install after major above-ceiling work is complete.
- B. Coordinate the location of hangers with other work.

3.03 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with ASTM C636/C636M and manufacturer's instructions and as supplemented in this section.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C. Lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size.
- D. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.

1. Use longest practical lengths.
- E. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- F. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- G. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- H. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
- I. Do not eccentrically load system or induce rotation of runners.

3.04 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Fit border trim neatly against abutting surfaces.
- D. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- E. Cutting Acoustical Units:
 1. Cut to fit irregular grid and perimeter edge trim.
 2. Make field cut edges of same profile as factory edges.
- F. Install hold-down clips on panels within 10 ft of an exterior door.

3.05 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.06 CLEANING

- A. Clean surfaces.
- B. Replace damaged or abraded components.

END OF SECTION

**SECTION 09 65 19
RESILIENT TILE FLOORING**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Resilient tile flooring.
- B. Installation accessories:
 - 1. Adhesives.
 - 2. Finishes and cleaners.

1.02 REFERENCE STANDARDS

- A. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50 mm [2 in.] Cube Specimens).
- B. ASTM D2047 - Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine.
- C. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.
- D. ASTM E662 - Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
- E. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
- F. ASTM F925 - Standard Test Method for Resistance to Chemicals of Resilient Flooring.
- G. ASTM F970 - Standard Test Method for Measuring Recovery Properties of Floor Coverings after Static Loading.
- H. ASTM F1514 - Standard Test Method for Measuring Heat Stability of Resilient Flooring by Color Change.
- I. ASTM F1515 - Standard Test Method for Measuring Light Stability of Resilient Flooring by Color Change.
- J. ASTM F1861 - Standard Specification for Resilient Wall Base.
- K. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
- L. ASTM F1914 - Standard Test Method for Short-Term Indentation and Residual Indentation of Resilient Floor Covering.
- M. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.
- N. ASTM F2199 - Standard Test Method for Determining Dimensional Stability of Resilient Floor Tile after Exposure to Heat.
- O. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.

1.03 SUBMITTALS

- A. Manufacturer's documentation for flooring and accessories:
 - 1. Technical Data.
 - 2. Installation and Maintenance.
- B. Selection Samples: Submit manufacturer's complete set of color samples for Contracting Officer or Contracting Officer's Representative's initial selection.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and that the material is of the correct style, color, quantity and run number(s).

- B. Store all materials flat and off of the floor in an acclimatized, weather-tight space between 65 to 85 degrees F.
- C. Do not double stack pallets.

1.05 FIELD CONDITIONS

- A. Acclimate material at jobsite between 65 to 85 degrees F and 35 percent to 85 percent relative humidity for 48 hours prior to installation. Temperature and relative humidity should also be maintained at the same levels during installation, and after installation.
- B. Spread unopened cartons no more than 6 cartons high and at least 4 inches apart.
- C. Keep away from heating and cooling ducts and direct sunlight.
- D. If permanent HVAC is not operational, temporary means should be used to maintain the recommended temperature and relative humidity levels.
- E. Close areas to traffic during installation of flooring and accessories.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than ten years of documented experience.

PART 2 PRODUCTS

2.01 RESILIENT TILE FLOORING

- A. Luxury Vinyl Plank and Tile:
 - 1. Pattern: As selected from manufacturer's full range.
 - 2. Color: As selected from manufacturer's full range.
 - 3. Physical Properties:
 - a. Construction: Phthalate-free solid plank and tile made from 100 percent virgin vinyl.
 - b. Wear Layer Thickness: 28 mil.
 - c. Total Thickness (Gauge): 0.126 inch.
 - 4. Manufacturing, Performance, and Safety Standards:
 - a. ASTM F1914, Residual Indentation: Surpasses requirements.
 - b. ASTM F2199, Dimensional Stability: Surpasses requirements.
 - c. ASTM F925, Chemical Resistance: Surpasses requirements.
 - d. ASTM F1514, Resistance to Heat: Surpasses requirements.
 - e. ASTM F1515, Resistance to Light: Surpasses requirements.
 - f. ASTM E648/NFPA 253, Critical Radiant Flux: Class I.
 - g. ASTM E662, Smoke Density (Flaming and Non-Flaming): Passes requirements.
 - h. ASTM D2047, Coefficient of Friction (Dry): Greater than or equal to 0.6.
 - i. ASTM F970, Static Load Limit: Greater than or equal to 1,000 pounds (surpasses requirements).

2.02 RESILIENT BASE

- A. Resilient Base: ASTM F1861, Type TS rubber, vulcanized thermoset; style as scheduled.
 - 1. Manufacturers:
 - a. Burke Flooring; Commercial Wall Base - TS: www.burkeflooring.com/#sle.
 - b. Flexco, Inc: www.flexcofloors.com/#sle.
 - c. Johnsonite, a Tarkett Company: www.johnsonite.com/#sle.
 - d. Roppe Corp: www.roppe.com/#sle.
 - e. Or approved equal.
 - 2. Height: 4 inch.
 - 3. Thickness: 0.125 inch.
 - 4. Finish: Satin.
 - 5. Length: Roll.
 - 6. Color: To be selected by Contracting Officer or Contracting Officer's Representative from manufacturer's full range.

7. Accessories: Premolded external corners and internal corners.

2.03 ACCESSORIES

- A. Moldings, Transition and Edge Strips: Same material as flooring.
- B. Adhesives:
 1. Type as recommended by manufacturer.
- C. Finishes and Cleaners:
 1. Type as recommended by manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION .

- A. Install flooring and accessories after other operations (including painting) have been completed.
- B. Acceptance of Conditions: Carefully examine all installation areas with installer/applicator present, for compliance with requirements affecting work performance.
 1. Verify that field measurements, product, adhesives, substrates, surfaces, structural support, tolerances, levelness, temperature, humidity, moisture content level, pH, cleanliness and other conditions are as required by the manufacturer, and ready to receive work.
- C. Verify that substrate is contaminant-free, including old adhesives and abatement chemicals.
- D. Test substrates as required by manufacturer to verify proper conditions exist.
 1. Concrete:
 - a. Check for concrete additives such as fly ash, curing compounds, hardeners, or other surface treatments that may prevent proper bonding of floor coverings.
 - b. Moisture testing: Perform either the In-Situ Relative Humidity (RH) test (ASTM F2170) or Moisture Vapor Emission Rate (MVER) test (ASTM F1869). Refer to the Manufacturer's Installation Guide/Manual for the maximum allowable substrate moisture content. Substrates above the maximum allowable moisture content will require a moisture mitigation system.
 - c. Perform alkalinity testing per ASTM F710 to verify pH level is between 7 to 10.
 - d. Check substrate for absorbency per manufacturer's recommendations.
 - e. Perform bond testing per ASTM F710 to determine compatibility of adhesive to concrete substrate.
- E. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A. Flooring installation should not begin until all site conditions have been assessed, testing has been completed and subfloor conditions have been approved.
- B. Prepare per manufacturer's written instructions and as follows:
 1. Prepare substrates to ensure proper adhesion of Luxury Vinyl Plank & Tile.
 2. Concrete Substrates: Prepare substrate per ASTM F710.
 - a. Verify that subfloor is clean, flat, smooth, free of dirt, rust, paint, oil, wax or any contaminant that will interfere with adhesive bonding.
 - b. Mechanically remove substrate coatings that are not compatible with adhesives, such as sealers, curing, hardening or parting compounds, soap, wax, oil, etc.
 - 1) Do not use solvents or adhesive removers.
 - c. Expansion joints, isolation joints, or other moving joints must be honored and must not be filled with underlayment products or other materials, and floor coverings must not be laid over them. Expansion joint covering systems should be detailed by the architect or engineer, and based upon intended usage and aesthetic considerations.
 - d. Surface cracks, grooves, depressions, control joints or other non-moving joints, and other irregularities shall be filled or smoothed with high-quality Portland cement or calcium aluminate based patching or underlayment compound for filling or smoothing, or both.

- 1) Do not skim-coat large areas with patching compound, especially slick power-troweled surfaces.
- 2) Sand smooth per manufacturer's instructions.
- e. Slick surfaces such as power-troweled concrete shall be profiled as needed to allow for a mechanical bond between the adhesive and subfloor.
- f. Do not use gypsum-based underlayment products and do not skim coat concrete subfloors.
- g. Self-Leveling Underlayments: Provide a dry and smoothly-sanded underlayment substrate ready for installation of Luxury Vinyl Plank & Tile. Underlayment compound shall be moisture-resistant, mildew-resistant, and alkali-resistant and must have a minimum of 3,000 psi compressive strength per ASTM C109/C109M.
- h. Lightweight concrete shall have a compressive strength greater than 90 pounds per cubic foot with minimum compression strength of 2,500 psi or greater.

3.03 INSTALLATION

- A. Installation per manufacturer's written instructions and as follows:
 1. Follow layout and ensure installation reference lines are square.
 2. Expansion Joints: Locate expansion, isolation, and other moving joints prior to installation.
 - a. Do not fill expansion, isolation, and other moving joints with patching compound nor cover with resilient flooring.
 - b. Install movement joint systems per manufacturer's instructions.
 3. Adhesives: Adhere flooring to substrate using the full spread method resulting in a completed installation without gaps, voids, raised edges, bubbles or any other surface imperfections.
 - a. Select appropriate adhesive, trowel and follow manufacturer's instructions.
 - b. Periodically spot-check transfer of adhesive to back of tile during installation.
 - c. Roll floor with a 100 pound roller to ensure proper transfer of adhesive and bonding.
 - d. Protect floor from traffic per manufacturer's instructions.
 - e. Do not wet mop floor until the adhesive has properly set per written instructions.

3.04 INSTALLATION - RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.
- B. Miter internal corners. At external corners, use premolded units. At exposed ends, use premolded units.
- C. Install base on solid backing. Bond tightly to wall and floor surfaces.
- D. Scribe and fit to door frames and other interruptions.

3.05 CLEANING

- A. Provide final cleaning immediately prior to Date of Substantial Completion inspection per manufacturer's written instructions and Section 01 7000.
 1. Protection: Remove manufacturer's and other installed protection immediately prior to Date of Substantial Completion inspection, unless required otherwise.
 2. Clean floor with a neutral 6-8 pH cleaner.

3.06 MAINTENANCE

- A. Initial maintenance per flooring manufacturer's written instructions and as follows:
 1. Allow the adhesive to cure for at least 48 hours prior to wet cleaning the floor.
 2. Sweep, dust mop or vacuum the floor thoroughly to remove all loose dirt, dust, grit and debris. Do not use vacuums with a beater bar assembly.
 3. Remove any dried adhesive residue from the surface with mineral spirits applied to a clean, lint-free cloth.
 4. Damp mop the floor using a cleaner recommended by the flooring manufacturer.

5. If necessary, scrub the floor using an auto scrubber or rotary machine (300 rpm or less) with a cleaner recommended by the flooring manufacturer. Maintain the proper dilution ratio and use the appropriate scrubbing brush or pad.
6. Thoroughly rinse the entire floor with fresh, clean water. Remove the dirty residue with a wet-vacuum or clean mop and allow the floor to dry completely.

3.07 PROTECTION

- A. Protect materials from construction operations until Date of Substantial Completion or Owner occupancy, whichever occurs first.
 1. Protect finished floor from abuse and damage by using heavy non-staining kraft paper, drop cloths or equivalent. Use additional, non-damaging protective materials as needed.
 2. Light foot traffic on a newly installed floor can be permitted after 24 hours.
 3. Keep heavy traffic and rolling loads off the newly installed LVT flooring for 48 hours.
 4. Protect the floor from rolling loads by covering with protective boards.

END OF SECTION

**SECTION 09 91 23
INTERIOR PAINTING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Surface preparation.
- B. Field application of paints.
- C. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.
 - 1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
 - 2. Elevator pit ladders.
 - 3. Mechanical and Electrical:
 - a. In finished areas, paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
 - b. In finished areas, paint shop-primed items.
- D. Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
 - 5. Stainless steel, anodized aluminum, bronze, terne coated stainless steel, and lead items.
 - 6. Marble, granite, slate, and other natural stones.
 - 7. Floors, unless specifically indicated.
 - 8. Ceramic and other tiles.
 - 9. Brick, architectural concrete, cast stone, integrally colored plaster and stucco.
 - 10. Glass.
 - 11. Concealed pipes, ducts, and conduits.

1.02 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency.
- B. ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating.
- C. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials.
- D. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association.
- E. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual.
- F. SSPC-SP 1 - Solvent Cleaning.
- G. SSPC-SP 13 - Surface Preparation of Concrete.

1.03 SUBMITTALS

- A. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
 - 2. MPI product number (e.g. MPI #47).

3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.
- B. Samples: Submit two paper chip samples, 4x4 inch in size illustrating range of colors and textures available for each surface finishing product scheduled.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum three years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.06 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Do not apply materials when relative humidity exceeds 85 percent; at temperatures less than 5 degrees F above the dew point; or to damp or wet surfaces.
- D. Minimum Application Temperatures for Paints: 50 degrees F for interiors unless required otherwise by manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide paints and finishes from the same manufacturer to the greatest extent possible.
 1. Substitution of MPI-approved products by a different manufacturer is preferred over substitution of unapproved products by the same manufacturer.
- B. Paints:
 1. Behr Process Corporation: www.behr.com/#sle.
 2. Pittsburgh Paints: www.ppgpaints.com/#sle.
 3. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
 4. Or approved equal.
- C. Primer Sealers: Same manufacturer as top coats.

2.02 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready mixed, unless intended to be a field-catalyzed paint.
 1. Where MPI paint numbers are specified, provide products listed in Master Painters Institute Approved Product List, current edition available at www.paintinfo.com, for specified MPI categories, except as otherwise indicated.
 2. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 3. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
 4. Supply each paint material in quantity required to complete entire project's work from a single production run.

5. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- B. Volatile Organic Compound (VOC) Content:
 1. Provide paints and finishes that comply with the most stringent requirements specified in the following:
 - a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
 - b. Ozone Transport Commission (OTC) Model Rule, Architectural, Industrial, and Maintenance Coatings; www.otcair.org; specifically:
 - 1) Opaque, Flat: 50 g/L, maximum.
 - 2) Opaque, Nonflat: 150 g/L, maximum.
 - 3) Opaque, High Gloss: 250 g/L, maximum.
 2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.
- C. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Contracting Officer or Contracting Officer's Representative from the manufacturer's full line.
- D. Colors: As indicated on drawings.
 1. In finished areas, finish pipes, ducts, conduit, and equipment the same color as the wall/ceiling they are mounted on/under.

2.03 PAINT SYSTEMS - INTERIOR

- A. Paint I-OP - Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board, concrete, concrete masonry units, wood, uncoated steel, shop primed steel, and galvanized steel.
 1. Two top coats and one coat primer.
 2. Top Coat(s): Interior Latex; MPI #43, 44, 52, 53, 54, or 114.
 3. Top Coat Sheen:
 - a. Flat: MPI gloss level 1; use this sheen for ceilings and other overhead surfaces.
 - b. Eggshell: MPI gloss level 3; use this sheen at all locations.
 - c. Satin: MPI gloss level 4; use this sheen for items subject to frequent touching by occupants, including door frames and railings.
 4. Primer: As recommended by top coat manufacturer for specific substrate.
- B. Paint I-OP-MD-DT - Medium Duty Door/Trim: For surfaces subject to frequent contact by occupants, including metals and wood:
 1. Medium duty applications include doors, door frames, railings, handrails, guardrails, and balustrades.
 2. Two top coats and one coat primer.
 3. Top Coat(s): Interior Epoxy-Modified Latex; MPI #115 or 215.
 - a. Products:
 - 1) Pittsburgh Paints Aquapon WB EP Two-Component Waterborne Epoxy Coating, 98E-1/98E-100 Series, Semi-Gloss. (MPI #215)
 - 2) Sherwin-Williams Waterbased Catalyzed Epoxy, Semi-Gloss.
- C. Paint I-OP-DF - Dry Fall: Metals; exposed structure and overhead-mounted services in utilitarian spaces, including shop primed steel deck, structural steel, metal fabrications, galvanized ducts, galvanized conduit, and galvanized piping.
 1. Shop primer by others.
 2. One top coat; white.
 3. Top Coat: Latex Dry Fall; MPI #118, 155, or 226.
 4. Top Coat Sheen:
 - a. Flat: MPI gloss level 1; use this sheen at all locations.

- D. Paint I-TR-C - Transparent Finish on Concrete Floors.
 - 1. 2 coats sealer.
 - 2. Sealer: Water Based Sealer for Concrete Floors; MPI #99.
 - a. Products:
 - 1) Behr Premium Wet-Look Sealer High Gloss [No. 985]. (MPI #99)
 - 2) Pittsburgh Paints Perma-Crete Plex-Seal WB Interior/Exterior Clear Sealer, 4-6200XI, Satin. (MPI #99)
 - 3) Sherwin-Williams H&C Clarishield Water-Based Wet-Look Concrete Sealer. (MPI #99)

2.04 ACCESSORY MATERIALS

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin application of paints and finishes until substrates have been properly prepared.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially effect proper application.
- D. Test shop-applied primer for compatibility with subsequent cover materials.
- E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Gypsum Wallboard: 12 percent.
 - 2. Masonry, Concrete, and Concrete Masonry Units: 12 percent.
 - 3. Interior Wood: 15 percent, measured in accordance with ASTM D4442.
 - 4. Concrete Floors and Traffic Surfaces: 8 percent.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Concrete:
 - 1. 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.
 - 2. Clean concrete according to ASTM D4258. Allow to dry.
 - 3. Prepare surface as recommended by top coat manufacturer and according to SSPC-SP 13.
- F. Masonry:
 - 1. Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions. Allow to dry.
 - 2. Prepare surface as recommended by top coat manufacturer.
- G. Concrete Floors and Traffic Surfaces: Remove contamination, acid etch, and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.

- H. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.
- I. Galvanized Surfaces:
 - 1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
- J. Ferrous Metal:
 - 1. Solvent clean according to SSPC-SP 1.
 - 2. Shop-Primed Surfaces: 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.
 - 3. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 "Commercial Blast Cleaning". Protect from corrosion until coated.
- K. Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.
- L. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 APPLICATION

- A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- B. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- C. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.
- D. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- E. Apply each coat to uniform appearance in thicknesses specified by manufacturer.
- F. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.
- G. Sand wood and metal surfaces lightly between coats to achieve required finish.
- H. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- I. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.05 PROTECTION

- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION

**SECTION 10 14 00
SIGNAGE****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Room and door signs.

1.02 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines.
- B. ADA Standards - 2010 ADA Standards for Accessible Design.
- C. ICC A117.1 - Accessible and Usable Buildings and Facilities.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Package signs as required to prevent damage before installation.
- B. Package room and door signs in sequential order of installation, labeled by floor or building.
- C. Store tape adhesive at normal room temperature.

1.05 FIELD CONDITIONS

- A. Do not install tape adhesive when ambient temperature is lower than recommended by manufacturer.
- B. Maintain this minimum temperature during and after installation of signs.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Flat Signs:
 - 1. Best Sign Systems, Inc: www.bestsigns.com/#sle.
 - 2. FASTSIGNS: www.fastsigns.com/#sle.
 - 3. Mohawk Sign Systems, Inc: www.mohawksign.com/#sle.
 - 4. Seton Identification Products: www.seton.com/aec/#sle.
 - 5. Or approved equal.

2.02 SIGNAGE APPLICATIONS

- A. Accessibility Compliance: Signs are required to comply with ADA Standards and ICC A117.1 and applicable building codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.
- B. Room and Door Signs: Provide a sign for every doorway, whether it has a door or not, not including corridors, lobbies, and similar open areas.
 - 1. Sign Type: Flat signs with engraved panel media as specified.
 - 2. Provide "tactile" signage, with letters raised minimum 1/32 inch and Grade II braille.
 - 3. Character Height: 1 inch.
 - 4. Sign Height: 2 inches, unless otherwise indicated.
 - 5. Office Doors: Identify with room numbers to be determined later, not the numbers indicated on drawings; in addition, provide "window" section for replaceable occupant name.
 - 6. Conference and Meeting Rooms: Identify with room numbers to be determined later, not the numbers indicated on drawings.
 - 7. Service Rooms: Identify with room names and numbers to be determined later, not those indicated on drawings.

8. Rest Rooms: Identify with pictograms, the names "MEN" and "WOMEN", room numbers to be determined later, and braille.
- C. Interior Directional and Informational Signs:
 1. Sign Type: Same as room and door signs.
 2. Sizes: As indicated on drawings.
 3. Wording of signs is scheduled on drawings.

2.03 SIGN TYPES

- A. Flat Signs: Signage media without frame.
 1. Edges: Square.
 2. Corners: Square.
 3. Wall Mounting of One-Sided Signs: Tape adhesive.
- B. Color and Font: Unless otherwise indicated:
 1. Character Font: Helvetica, Arial, or other sans serif font.
 2. Character Case: Upper case only.
 3. Background Color: Blue.
 4. Character Color: Contrasting color.

2.04 ACCESSORIES

- A. Tape Adhesive: Double sided tape, permanent adhesive.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install neatly, with horizontal edges level.
- C. Locate signs and mount at heights indicated on drawings and in accordance with ADA Standards and ICC A117.1.
- D. Protect from damage until Date of Substantial Completion; repair or replace damaged items.

END OF SECTION

**SECTION 10 21 13.13
METAL TOILET COMPARTMENTS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Metal toilet compartments.
- B. Urinal screens.

1.02 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- B. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

1.03 ADMINISTRATIVE REQUIREMENTS**1.04 SUBMITTALS**

- A. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall and floor supports, door swings.
- B. Product Data: Provide data on panel construction, hardware, and accessories.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Metal Toilet Compartments:
 - 1. All American Metal Corp - AAMCO; Powder-Coated Steel: www.allamericanmetal.com/#sle.
 - 2. ASI Global Partitions; Powder Coated Steel: www.asi-globalpartitions.com/#sle.
 - 3. Hadrian; Hadrian - Standard Series - Powder Coated: www.hadrian-inc.com/#sle.
 - 4. Metpar Corp: www.metpar.com/#sle.
 - 5. Monarch Toilet Partition Inc: www.monarchpartition.com/#sle.
 - 6. Partition Manufacturers of America, Inc: www.partitioninc.com/#sle.
 - 7. Or approved equal.

2.02 MATERIALS

- A. Steel Sheet: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.

2.03 COMPONENTS

- A. Toilet Compartments: Powder coated steel, floor-mounted headrail-braced.
- B. Doors, Panels, and Pilasters: Sheet steel faces, pressure bonded to sound-deadening core, corners made with corner clips or mitered, welded, and ground smooth.
 - 1. Panel Faces: 22 gauge, 0.0299 inch.
 - 2. Door Faces: 22 gauge, 0.0299 inch.
 - 3. Pilaster Faces: 22 gauge, 0.0299 inch.
 - 4. Reinforcement: 12 gauge, 0.1046 inch.
 - 5. Internal Reinforcement: Provide in areas of attached hardware and fittings. Mark locations of reinforcement for partition mounted washroom accessories.
- C. Door and Panel Dimensions:
 - 1. Thickness: 1 inch.
 - 2. Door Width: 24 inches.
 - 3. Door Width for Handicapped Use: 36 inch , out-swinging.
 - 4. Height: 63-1/2 inches.
- D. Pilasters: 1-1/4 inch thick, of sizes required to suit compartment width and spacing.

- E. Urinal Screen Splash Panels: Stainless steel sheet 30 inch wide by 42 inch high mounted on partitions adjacent to urinals. Fasten with stainless steel screws spaced 8 inches on center.

2.04 ACCESSORIES

- A. Pilaster Shoes: Formed ASTM A666 Type 304 stainless steel with No.4 finish, 3 inches high, concealing floor fastenings.
 - 1. Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster.
- B. Head Rails: Hollow anodized aluminum tube, 1 by 1-5/8 inches in size, with anti-grip strips and cast socket wall brackets.
- C. Brackets: Polished chrome-plated non-ferrous cast metal.
- D. Attachments, Screws, and Bolts: Chrome-plated steel, tamper-proof type.
- E. Hardware: Polished chrome plated non-ferrous cast metal:
 - 1. Pivot hinges, gravity type, adjustable for door close positioning; two per door.
 - 2. Thumb turn or sliding door latch with exterior emergency access feature.
 - 3. Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.
 - 4. Coat hook with rubber bumper; one per compartment, mounted on door.
 - 5. Provide door pull for outswinging doors.

2.05 FINISHING

- A. Powder-Coated Steel Compartments: Manufacturer's standard process. Clean, degrease, and neutralize.
- B. Color: Single color as selected.
- C. Stainless Steel Compartments: No. 4 finish.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that field measurements are as indicated.
- C. Verify correct spacing of and between plumbing fixtures.
- D. Verify correct location of built-in framing, anchorage, and bracing.

3.02 INSTALLATION

- A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.
- B. Maintain 3/8 to 1/2 inch space between wall and panels and between wall and end pilasters.
- C. Attach panel brackets securely to walls using anchor devices.
- D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.

3.03 TOLERANCES

- A. Maximum Variation From True Position: 1/4 inch.
- B. Maximum Variation From Plumb: 1/8 inch.

3.04 ADJUSTING

- A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch.
- B. Adjust hinges to position doors in partial opening position when unlatched. Return out swinging doors to closed position.
- C. Adjust adjacent components for consistency of line or plane.

END OF SECTION

**SECTION 10 22 39
FOLDING PANEL PARTITIONS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Top-supported folding panel partitions, horizontal opening.

1.02 REFERENCE STANDARDS

- A. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- B. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- D. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- E. ASTM E413 - Classification for Rating Sound Insulation.
- F. ASTM E557 - Standard Guide for Architectural Design and Installation Practices for Sound Isolation Between Spaces Separated by Operable Partitions.
- G. ASTM E596 - Standard Test Method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures.
- H. ASTM F793/F793M - Standard Classification of Wall Coverings and Ceiling Coverings by Use Characteristics.

1.03 SUBMITTALS

- A. Product Data: Provide data on partition materials, operation, hardware and accessories, and colors and finishes available.
- B. Design Data: Design calculations, bearing seal and signature of structural engineer licensed to practice in the Commonwealth of Pennsylvania, showing loads at points of attachment to the building structure.
- C. Shop Drawings: Indicate opening sizes, track layout, details of track and required supports, static and dynamic loads, location and details of pass door and frame, adjacent construction and finish trim, and stacking depth.
- D. Samples for Selection: Submit two samples of full manufacturer's color range for selection of colors.

1.04 QUALITY ASSURANCE**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Store products in manufacturer's unopened packaging until installation.

1.06 WARRANTY

- A. Correct defective Work within five year period after Date of Substantial Completion.
- B. Provide two year manufacturer warranty against defects in material and workmanship, excluding abuse.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Folding Panel Partitions - Horizontal Opening:
 - 1. Moderco, Inc: www.moderco.com/#sle.
 - 2. Modernfold, a DORMA Group Company; Acousti-Seal Premier series: www.modernfold.com/#sle.
 - 3. Or approved equal.

2.02 FOLDING PANEL PARTITIONS - HORIZONTAL OPENING

- A. Folding Panel Partitions: Side opening; paired panels; side stacking; manually operated.
- B. Panel Construction:
 - 1. Frame: 18 gauge, 0.0478 inch thick formed sheet steel frame top, bottom, jambs, and intermediates; welded construction, with acoustical insulation fill.
 - 2. Substrate: Medium-density fiberboard.
 - 3. Panel Substrate Facing: Steel sheet, manufacturer's standard thickness.
 - 4. Hinges: Continuous piano type, stainless steel.
 - 5. Hardware: Latching door handles of cast steel, satin chrome finish; lock cylinder keyed to building keying system; pull bars.
 - 6. Panel Properties:
 - a. Thickness With Finish: 3 inches.
 - b. Width: Standard width.
 - c. Weight: 8 lb/sq ft.
- C. Panel Finishes:
 - 1. Facing: Vinyl coated fabric.
 - 2. Exposed Metal Trim: Custom powder coated paint finish.
- D. Panel Seals:
 - 1. Panel to Panel Seals: Grooved and gasketed astragals, with continuous flexible ribbed vinyl seal fitted to panel edge construction; color to match panel finish.
 - 2. Acoustic Seals: Flexible acoustic seals at jambs, meeting mullions, ceilings, retractable floor and ceiling seals, and above track to structure acoustic seal.
- E. Suspension System:
 - 1. Track: Formed steel; 1-1/4 by 1-1/4 inch size; thickness and profile designed to support loads, steel sub-channel and track connectors, and track switches.
 - 2. Carriers: Nylon wheels on trolley carrier at top of every second panel, sized to carry imposed loads, with threaded pendant bolt for vertical adjustment.
- F. Performance:
 - 1. Acoustic Performance:
 - a. Noise Reduction Coefficient (NRC): ASTM E596, NRC of 0.65 minimum.
 - b. Sound Transmission Class (STC): 43 to 47 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90, on panel size of 100 sq ft.
 - 2. Surface Burning Characteristics of Panel Finish: Flame spread/smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84.
 - 3. Installed partition system track capable of supporting imposed loads, with maximum deflection of 1/360 of span.
- G. Accessories:
 - 1. Ceiling Closure: White enameled ceiling closure; aluminum jamb and head molding, fittings and attachments, and intermediate meeting posts.
 - 2. Acoustic Sealant: As recommended by partition manufacturer.

2.03 MATERIALS

- A. Aluminum Extrusions: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.
- B. Vinyl Coated Fabric: ASTM F793 Category VI, polyvinyl fluoride (PVC) finish for washability and improved flame retardance; color as selected by Architect from manufacturer's standard range.
- C. Acoustic Insulation:
 - 1. Type: As required for acoustic performance indicated.
 - 2. Thickness: As required for acoustic performance indicated.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify track supports are laterally braced and will permit track to be level within 1/4 inch of required position and parallel to the floor surface.
- C. Verify floor flatness of 1/8 inch in 10 feet, non-cumulative.
- D. Verify wall plumbness of 1/8 inch in 10 feet, non-cumulative.

3.02 INSTALLATION

- A. Install partition in accordance with manufacturer's instructions and ASTM E557.
- B. Fit and align partition assembly level and plumb.
- C. Lubricate moving components.
- D. Install acoustic sealant to achieve required acoustic performance.
- E. Coordinate electrical connections.

3.03 ADJUSTING

- A. Adjust partition assembly to provide smooth operation from stacked to full open position. Do not over-compress acoustic seals.
- B. Visually inspect partition in full extended position for light leaks to identify a potential acoustical leak.
- C. Adjust partition assembly to achieve lightproof seal.

3.04 CLEANING

- A. Clean finish surfaces and partition accessories.

END OF SECTION

**SECTION 10 28 00
TOILET, BATH, AND LAUNDRY ACCESSORIES**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Commercial toilet accessories.
- B. Utility room accessories.

1.02 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- D. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- E. ASTM C1036 - Standard Specification for Flat Glass.
- F. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror.
- G. ASTM D4802 - Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.04 SUBMITTALS

- A. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Commercial Toilet, Shower, and Bath Accessories:
 - 1. American Specialties, Inc: www.americanspecialties.com/#sle.
 - 2. Bobrick Washroom Equipment, inc: www.bobrick.com
 - 3. Bradley Corporation: www.bradleycorp.com/#sle.
 - 4. Georgia-Pacific Professional: www.gppro.com/#sle.
 - 5. Kimberly-Clark Corporation: www.kcprofessional.com/#sle.
 - 6. Or approved equal.

2.02 MATERIALS

- A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
 - 1. Grind welded joints smooth.
 - 2. Fabricate units made of metal sheet of seamless sheets with flat surfaces.
- B. Keys: Provide two keys for each accessory to Government; master key lockable accessories.
- C. Stainless Steel Sheet: ASTM A666/A666M, Type 304.
- D. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.
- E. Galvanized Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.
- F. Acrylic Plastic Sheet: ASTM D4802.

- G. Mirror Glass: Annealed float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.
- H. Adhesive: Two component epoxy type, waterproof.
- I. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.

2.03 FINISHES

- A. Stainless Steel: Satin finish, unless otherwise noted.
- B. Baked Enamel: Pretreat to clean condition, apply one coat primer and minimum two coats epoxy baked enamel.
- C. Galvanizing for Items Other than Sheet: Comply with ASTM A123/A123M; galvanize ferrous metal and fastening devices.

2.04 COMMERCIAL TOILET ACCESSORIES

- A. Toilet Paper Dispenser: Double roll, surface mounted bracket type, stainless steel, spindleless type for tension spring delivery designed to prevent theft of tissue roll.
- B. Combination Towel Dispenser/Waste Receptacle: Semi-recessed with projecting waste receptacle, stainless steel; seamless wall flanges, continuous piano hinges, tumbler locks on upper and lower doors.
 - 1. Towel dispenser capacity: 400 C-fold.
 - 2. Waste receptacle capacity: 4 gallons.
- C. Automated Soap Dispenser: Liquid soap dispenser, wall-mounted, with stainless steel cover and window to gauge soap level, tumbler lock.
 - 1. Minimum Capacity: 30 ounces.
- D. Mirrors: Stainless steel framed, 1/4 inch thick annealed float glass; ASTM C1036.
 - 1. Annealed Float Glass: Silvering, protective and physical characteristics in compliance with ASTM C1503.
 - 2. Size: As indicated on drawings.
 - 3. Frame: 0.05 inch angle shapes, with mitered and welded and ground corners, and tamperproof hanging system; satin finish.
- E. Grab Bars: Stainless steel, smooth surface.
 - 1. Standard Duty Grab Bars:
 - a. Push/Pull Point Load: 250 pound-force, minimum.
 - b. Dimensions: 1-1/4 inch outside diameter, minimum 0.05 inch wall thickness, exposed flange mounting, 1-1/2 inch clearance between wall and inside of grab bar.
 - c. Finish: Satin.
 - d. Length and Configuration: As indicated on drawings.
- F. Sanitary Napkin Disposal Unit: Stainless steel, surface-mounted, self-closing door, locking bottom panel with full-length stainless steel piano-type hinge, removable receptacle.

2.05 UTILITY ROOM ACCESSORIES

- A. Mop and Broom Holder: 0.05 inch thick stainless steel, Type 304, hat-shaped channel.
 - 1. Holders: Three spring-loaded rubber cam holders.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.
- C. Verify that field measurements are as indicated on drawings.
- D. See Section 06 10 00 for installation of blocking, reinforcing plates, and concealed anchors in walls.

3.02 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

3.03 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.

3.04 PROTECTION

- A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION

**SECTION 10 44 00
FIRE PROTECTION SPECIALTIES**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.
- C. Accessories.

1.02 REFERENCE STANDARDS

- A. FM (AG) - FM Approval Guide.
- B. NFPA 10 - Standard for Portable Fire Extinguishers.
- C. UL (DIR) - Online Certifications Directory.

1.03 SUBMITTALS

- A. Product Data: Provide extinguisher operational features.
- B. Shop Drawings: Indicate locations of cabinets and cabinet physical dimensions.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.04 FIELD CONDITIONS

- A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Fire Extinguishers:
 - 1. Activar Construction Products Group, Inc. - JL Industries; Cosmic Extinguisher - Multipurpose Chemical: www.activarcpg.com/#sle.
 - 2. Or approved equal.
- B. Fire Extinguisher Cabinets and Accessories:
 - 1. Activar Construction Products Group, Inc. - JL Industries; Ambassador Series: www.activarcpg.com/#sle.
 - 2. Or approved equal.

2.02 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
 - 1. Provide extinguishers labeled by UL (DIR) or FM (AG) for purpose specified and as indicated.
- B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
 - 1. Stored Pressure Operated: Deep Drawn.
 - 2. Class: A:B:C type.
 - 3. Size: 10 pound.
 - 4. Finish: Baked polyester powder coat, red color.
 - 5. Temperature range: Minus 65 degrees F to 120 degrees F.

2.03 FIRE EXTINGUISHER CABINETS

- A. Cabinet Construction: Non-fire rated.
 - 1. Formed primed steel sheet; 0.036 inch thick base metal.
- B. Cabinet Configuration: Semi-recessed type.
 - 1. Size to accommodate accessories.
 - 2. Trim: Flat rolled edge, with 3 inch wide face.

- 3. Provide cabinet enclosure with right angle inside corners and seams, and with formed perimeter trim and door stiles.
- C. Door: 0.036 inch metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinges.
- D. Door Glazing: Acrylic plastic, clear, 1/8 inch thick, flat shape and set in resilient channel glazing gasket.
- E. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
- F. Fabrication: Weld, fill, and grind components smooth.
- G. Finish of Cabinet Exterior Trim and Door: No.4 - Brushed stainless steel.
- H. Finish of Cabinet Interior: White colored enamel.

2.04 ACCESSORIES

- A. Extinguisher Brackets: Formed steel, chrome-plated.
- B. Lettering: "FIRE EXTINGUISHER" decal, or vinyl self-adhering, prespaced black lettering in accordance with authorities having jurisdiction (AHJ).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install cabinets plumb and level in wall openings, 24 inches from finished floor to inside bottom of cabinet.
- C. Secure rigidly in place.
- D. Place extinguishers in cabinets.

END OF SECTION

**SECTION 11 05 00
COMMON WORK RESULTS FOR SHOP EQUIPMENT**

PART 1 GENERAL**1.01 SUMMARY**

- A. This section includes the following:
 - 1. Basic materials, methods, processes and documentation, which are applicable to the design, fabrication, installation and testing of all equipment items and systems specified in Sections 41 22 13.13.
 - a. Furnish and install all equipment as specified, at locations shown on the Contract Drawings, complete, and ready for operation.
 - b. Design, fabricate, install, and adjust equipment to perform the specific operations and functions specified and also to provide special features described.
 - c. Whether specifically indicated or not, provide all accessories, devices, and/or other appurtenances, including mechanical, electrical, and structural items, which are necessary for equipment to be properly installed and completely functional.
 - d. Details listed in these specifications are given for a better understanding of the work required by the Contractor, and do not place a limitation on the amount of work to be done nor do they relieve the Contractor of additional work that may be required for a complete installation.
 - e. Remove, relocate, and repair any items that are necessary for installation of the equipment at no additional cost to the Owner.
- B. RELATED SECTIONS
 - 1. Equipment suppliers and installers shall familiarize themselves with the requirements of these sections and incorporate applicable provisions into their work. Cooperate with other trades to facilitate execution of the work.
 - a. Division 01 – General Requirements
 - 1) Section 01 40 00 - Quality Requirements
 - 2) Section 01 60 00 - Product Requirements
 - 3) Section 01 78 00 – Closeout Submittals
 - b. Division 05 – Metals
 - c. Division 26 – Electrical
 - d. Section 41 22 13.13 - Bridge Crane

1.02 REFERENCE STANDARDS

- A. American Institute of Steel Construction (AISC)
- B. American National Standards Institute (ANSI)
- C. American Society of Mechanical Engineers (ASME):
 - 1. ASME B30.10, Hooks
 - 2. ASME B30.17, Cranes and Monorails (With Underhung Trolley or Bridge)
 - 3. ASME N30.18, Stacker Cranes (Top or Under Running Bridge, Multiple Girder with Top or Under Running Trolley Hoist)
 - 4. ASME B30.20, Below-the-Hook Lifting Devices
- D. American Society of Testing Materials (ASTM)
- E. American Welding Society (AWS)
- F. Crane Manufacturer's Association of America (CMAA):
 - 1. CMAA 74, Specification for Top Running and Under Running Single Girder Electric Overhead Cranes Utilizing Under Running Trolley Hoist
- G. Hoist Manufacturer's Institute (HMI)
- H. National Electric Manufacturers Association (NEMA)
- I. National Fire Protection Association (NFPA):

1. NFPA 70, National Electric Code
 2. NFPA 79, Electrical Standard for Industrial Machinery
- J. Comply with all applicable Federal and State regulatory requirements and with local codes having jurisdiction including, but not limited to:
1. Occupational Safety and Health Administration (OSHA)
 2. Building Code of the State of Pennsylvania and the International Building Code (IBC) as adopted therein.

1.03 SUBMITTALS

- A. Pursuant to the provisions of Terms and Conditions and as required herein, the Contractor shall submit:
1. Product data.
 2. Shop drawings.
 3. Samples
 4. Certificates
 5. Manufacturer's Instructions
- B. Product Data: Submit for each type of product specified.
1. Manufacturer's literature including brochures, catalog cuts, pamphlets, descriptive literature, and equipment specifications which adequately describe performance and test criteria, compliance with appropriate reference standards, characteristics, limitations, and trouble-shooting protocol for the piece of equipment or product.
 2. Product transportation, storage, handling and manufacturer's recommended installation instructions and drawings.
 3. List of recommended spare parts.
- C. Shop Drawings:
1. Layout drawings showing equipment, elevations, conduit runs, utilities and hook-ups, and all required dimensions. Drawings shall show plan and elevation views of all required conduit and piping runs. Equipment drawings shall clearly indicate all maintenance access points.
 2. Fabrication drawings, including bill of materials.
 3. Structural support drawings and elevations.
 4. Utility connection plan.
 5. Electrical equipment layout, with all motors, limit switches, solenoid valves, disconnects, control panels, emergency shut off switches, interlocks, accessories, all located and labeled. Include control and wiring diagrams.
 6. Complete engineering design data and calculations for equipment to confirm equipment meets design criteria specified.
- D. Samples: Paint / color selection.
- E. Certificates of Compliance in accordance with Article 1.04 F herein.
- F. Manufacturer's Instructions: Manufacturer's recommended installation instructions and manufacturer's installation drawings, handling, and storage requirements.
- G. Submit operation and maintenance manuals in accordance with per Division 01.
- H. Submit a testing schedule for each equipment item for approval prior to beginning the equipment testing and start-up. This schedule must be coordinated with the Owner.
- I. Submit warranty for each item as required herein and per Division 01.
- J. Provide Training Program as required herein and per Division 01.
- K. Submit an electronic file identifying both the preventative maintenance schedules as well as detailed maintenance notes for each piece of equipment installed under this contract.

1.04 QUALITY ASSURANCE

- A. General:

1. All articles, materials, fittings, equipment, and appurtenances incorporated in the work shall be new and unused, free from defects and imperfections, of first grade commercial quality, and shall, as far as practicable, be manufacturer's standard make. Manufacturers shall have proven experience in the design and manufacture of specified items, suitable for the purpose intended and subject to approval of the Owner.
- B. Standard of Quality:
 1. The model and manufacturer used as the Basis of Design establishes the standard of quality required for each item as described in Article 1.07A.
 2. A proposed alternate to be used in place of the Basis of Design must compare favorably in every way to the Basis of Design in order to be accepted as equal.
 3. For certain specialized equipment items and systems, the Owner is directing the Contractor to procure these items from selected pre-approved manufacturers. No alternates or substitutions will be permitted for these specialized items.
- C. Single Manufacturer:
 1. In all cases where the specifications refer to a device or part of the equipment in the singular number, such reference applies to as many such devices or parts as are required to complete the installation.
- D. Used/Obsolete Equipment Prohibited
- E. Applicable Codes:
 1. Work shall conform to Federal, State, and local governing rules and regulations and ordinances, including OSHA and NFPA requirements, and shall pass inspection by authorities having jurisdiction.
 2. Furnish all materials and labor above and beyond those required by these specifications in order to meet these requirements and to obtain approvals of inspections and tests.
- F. Certificates of Compliance:
 1. At the time equipment is delivered, provide Certificates of Compliance in accordance with the applicable requirements specified in Division 01. Each certificate shall be signed by an authorized representative of the manufacturer and shall state that the equipment complies in all respects with the Contract requirements.
 2. Contractor shall furnish an affidavit certifying that all materials and workmanship comply with the applicable code requirements.
 3. Before final acceptance, furnish certificates of the authorities having jurisdiction.
- G. Permits:
 1. Obtain all necessary permits from the State and other authorities having jurisdiction and notify the Owner when permits are acquired.
 2. Make application and file all drawings required for such permits, and pay all fees related to obtaining permits.
- H. Equipment Acceptance Process:
 1. The Work will be inspected for approval periodically during the course of construction by the Owner and by others having jurisdiction over the Work. Facilitate these inspections.
 2. Equipment acceptance is a 3-step process for each item:
 - a. Tentative Acceptance: Before shop drawings are submitted, a preliminary equipment list of proposed equipment items must be submitted for approval by the Owner. This list must be comprehensive and include enough information about the equipment, including manufacturers and model numbers, to show that each item complies with the Contract requirements. No consideration will be given to partial lists submitted at intervals. Approval of the preliminary equipment list by the Owner constitutes Tentative Acceptance of the proposed equipment pending submission of detailed shop drawings, product data, samples, and working drawings. No equipment installation will be permitted at this stage of the project.
 - b. Interim Acceptance: Following Tentative Acceptance of the equipment, submit shop drawings, product data, samples, and working drawings. Approval of these

submittals by the Architect and Owner constitutes Interim Acceptance of the equipment item, and provides authorization for purchasing, fabricating and/or installing that item as part of the Work.

- c. Final Acceptance: Following installation of an equipment item, demonstrate to the Owner that the equipment is fully functional and that it has passed all required performance testing. Show that required spare parts have been provided, and Warranties are being activated. Provide required equipment manuals. Provide all required training in accordance with this Section. Resolve all outstanding punch list items pertaining to the equipment. At the time of final inspection, furnish all certificates of approval by authorities having jurisdiction whenever applicable. When all the above stated tasks are completed, the equipment item will receive Final Acceptance. Refer to Division 01 for additional requirements.

1.05 DELIVERABLES

- A. Final Operation and Maintenance Data.
- B. Training Program:
 1. Operation and maintenance training programs are required for equipment items and systems specified herein.
 2. General Requirements: Provide training as outlined in this section.
 - a. Maintenance management classes are to take place prior to substantial completion of the facility. Mechanics training will commence only after installation of equipment is complete at the garage.
 - b. Training shall be conducted at the facility.
 - c. Hours for training are to be between 7:00 am and 3:00 pm unless specifically permitted otherwise.
 - d. Owner Personnel to be Trained:
 - 1) Mechanics: Minimum 8 hours.
 - 2) Maintenance Personnel: Minimum 8 hours.
 - 3) Supervisors: Minimum 2 hours.
 - e. Ensure that the instructors teaching these training courses are not only familiar with technical information, but able to utilize proper methods of instruction, training aids, audiovisuals, etc. to ensure effective presentations.
 - f. Provide all training aids, audiovisual equipment and visual aids for the conduct of these courses.
 - g. All training materials are to become the property of the Owner at the conclusion of training.
 - h. Submission and Approval of Training Plans:
 - 1) Meet with the Owner no later than three weeks prior to the start of formal training. At that time, submit lesson plans and an outline of training program, and demonstrate any training aids involved. Present handouts for approval and later provide handouts in a ratio of one per student. Each location shall receive a complete set of prints and schematics.
 - 2) Describe plans for meeting the specification training requirements. The Owner will approve and then coordinate and schedule all training involved with necessary personnel.
 - i. Outline specific objectives for each of the required training courses. Provide a detailed schedule outlining the length and content of each of these sessions in accordance with the guidelines established.
 - 1) The course includes sessions in safety, machine operation, a comprehensive seminar on learning basic skills/knowledge of each operation. The course shall include both classroom and practical exercise sessions and is to provide the maintenance staff with the basic knowledge necessary to utilize all training materials.

- 2) The training program shall include familiarization with safe equipment operation and performance and detailed instruction in operation, maintenance, and test procedures.
- C. Warranty: All equipment shall be warranted as a minimum in accordance with Division 01 and the following provisions:
1. The Contractor shall furnish a warranty covering all parts of the work performed, and all materials and equipment furnished hereunder by Contractor or his subcontractors or suppliers will be free from defects in design, material, workmanship and operation for a period of one year from the date of acceptance of the work.
 2. Warranty shall provide for 24 hour parts availability and 24 hour response time. Supplier shall maintain an adequate parts stock such that equipment down times attributable to unavailable typical repair parts shall be 48 hours or less during the first five (5) year period.
 3. The Contractor shall repair or pay for the repair of any such defect at his own expense.
 4. Work which has been abused or neglected is excluded from this warranty.
 5. Furnish written warranties required by the respective sections of the Specifications for time stipulated therein. These warranties shall be in writing, on the Contractor's or supplier's letterhead and shall be included in the operations and maintenance manual(s).
 6. Major equipment components, (as required by the respective sections of the specifications) specifically those manufactured by other than the primary equipment supplier, shall be covered by their own respective warranties, which shall not be less than the suppliers mandated one year warranty. These warranties shall also be included in the operations and maintenance manual(s).
 7. Nothing in these requirements, conditions or specifications including the Owner's right to a complete inspection shall constitute a disclaimer to or limit, negate, exclude, or modify in any way any warranty created hereunder.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliveries: Arrange deliveries of products in accordance with construction schedules and coordinate them to avoid conflict with the work, and conditions at the site.
1. Deliver products in undamaged condition, in the manufacturer's original containers or packaging with identifying labels intact and legible.
 2. Immediately upon delivery, inspect shipments to assure compliance with the requirements of the Contract Documents and approved submittals, and check that the products are properly protected and undamaged.
- B. Storage and Protection: Store and protect products, both on and off site, in accordance with the manufacturer's written instructions, with seals and labels intact and legible. All products shall be kept clean, dry, and free from damage, deterioration, paint, coatings, spills, spots, corrosion, or harm from any source. Storage shall provide easy access for inspection. Protect equipment during storage and prior to start-up, which shall include covering of openings, protection against rust and other damage, etc.
1. Mark and tag products with equipment item numbers.
 2. Store products subject to damage by the elements in watertight enclosures.
 3. Maintain indoor storage temperatures and humidity within the ranges required by the manufacturer's instructions. Store hazardous and flammable materials in containers and enclosures specifically designed for that purpose.
 4. Exterior storage: Store products above the ground, on blocking or skids; prevent soiling or staining. Cover products subject to deterioration or which absorb moisture with impervious sheet coverings. Provide adequate ventilation to avoid condensation. Products may be store outdoors only with approval of the Owner.
 5. Make periodic inspections of stored equipment and materials to assure that products are maintained under the specified conditions and free from damage or deterioration.
- C. Handling: Provide equipment and personnel to handle products using methods to prevent soiling or damaging products and packaging.

1. When unloading materials, equipment and machinery provide special lifting harness or apparatus as may be required by manufacturers. Handle material, equipment, and machinery in accordance with manufacturer's written instructions.
 2. When transporting materials, equipment, and machinery both on site and from Contractor's storage to site, do so in accordance with recommendations of respective manufacturers of each.
- D. Pay demurrage charges and claims for damage resulting from unloading operations.

1.07 GENERAL DESIGN AND FABRICATION REQUIREMENTS

- A. Basis of Design:
1. For a particular equipment item or system, the specific model and manufacturer which is listed first in PART 2 – PRODUCTS within the specification section for that item is the Basis of Design used to design this facility.
 2. An item's Basis of Design establishes the type, size, and quality of equipment required for that item.
 3. Models and manufacturers other than the Basis of Design listed in PART 2 – PRODUCTS within the specification section for an item will be considered accepted equivalents for that item if they are provided with the modifications, options and/or accessories required to provide the type, size, features, and quality provided by the Basis of Design; except for instances where the Owner has directed the purchase of an item from a pre-approved manufacturer. In those cases, equipment substitutions or alternates are not permitted.
- B. Equipment shall comply with 49 CFR Part 661 - Buy America Requirements.
- C. Equipment shall be designed, fabricated, installed, and adjusted to secure the best commercially available results with respect to smooth, quiet, convenient, and efficient operation, durability, economy of maintenance and operation, and the highest standards of safety.
- D. It is not the intent of these Specifications to detail the design and fabrication of the several parts of the equipment, but it is expected that the type, material, design, workmanship and fabrication of each and every part shall be fully adequate for the service required, durable, properly coordinated with all other parts, in accordance with the best commercial standards and of the highest commercial efficiency. The components of electric circuits shall be of ample and proper size, design and material to avoid injurious heating and arcing, and all other objectionable effects which may reduce the efficiency of operation and economy of maintenance and upkeep below the best commercially available results. Minimum requirements are given herein for the certain parts of equipment. Equivalent requirements approved by the Owner shall apply to such parts as are of special design, construction, or material and to which the specified requirements are not directly applicable. These minimum requirements as a whole shall also be considered as establishing proportionate general minimum standards for all parts of the equipment.
- E. The Owner may permit variations from the requirements of these Specifications to permit the use of the manufacturer's standard equipment, provided in his opinion such standard equipment is in every way adequate for the intended use and meets the full intent of these Specifications. All such variations proposed by the Contractor shall be called to the attention of the Owner in writing and shall be made only if approved in writing.
- F. Certain design limitation, tests, etc., are herein specified as a partial check on the adequacy of design, fabrication, and materials. These requirements do not cover all features necessary to insure satisfactory and approved operation of the equipment. Conformity with these requirements shall, in no way, supersede the general requirements as to satisfactory and efficient operation of the equipment.
- G. Space and Utility Accommodation:
1. Provide equipment suitable for installation in the space indicated.
 2. Provide equipment suitable for operation on available building utilities.
- H. Facility Modifications:

1. Any proposed modification or redesign to the building structure or utilities to accommodate an equipment item or system other than that used as the Basis of Design must first be approved by the Owner prior to beginning any construction and/or installation related to that item.
 2. Such modification and redesign will be at no additional cost to the Owner.
- I. Finishes:
1. Whenever available, factory-finish equipment with manufacturer's standard primer and finish coats. Otherwise shop prime equipment with one coat of approved rust-inhibitive paint containing at least 25 percent rust-inhibitive pigments and finish coat system. Indicate brand and type of paint on shop drawing.
 2. Where factory finishes are provided on equipment and no additional field painting is required, touch up or refinish all marred or damaged surfaces so as to leave a smooth, uniform finish at the time of final inspection.
- J. Identification Plates: A corrosion-resistant identification plate clearly marked and stamped with the manufacturer's name and address, model number, serial number, date of manufacture, and all pertinent utility and operating data (or ratings) shall be attached in a prominent location to each major piece of equipment.
- K. Electrical Power Supply:
1. Comply with the provisions of NFPA 79 Electrical Standard for Industrial Machinery.
 2. Provide transformers to step down supply voltage to provide low voltage for controls and accessories and to provide voltage compatible with equipment whenever necessary for equipment to function as specified.
- L. Electrical Components:
1. Starters, controllers, and start-stop stations shall be provided by the equipment manufacturer.
 2. Provide all electrical components with ample and proper capacity, design, and material to avoid injurious heating and arcing, and all other objectionable effects which reduce operational efficiency and interfere with efficient maintenance and upkeep.
- M. Electrical Wiring and Conduit:
1. Provide wiring and conduit for complete installation of all equipment and accessories which is adequate for proper equipment operation.
 2. Wire, cable, and conduit for light, power and signal circuits shall conform to those specified in the National Electrical Code and NFPA 79 Electrical Standard for Industrial Machinery. In no case shall maximum current carried exceed that specified by National Electrical Code for type of conductor used.
 3. All wiring and conduit required for the equipment installation shall be in accordance with the applicable portions of Division 26.
- N. Controls:
1. Provide control devices necessary for proper operation of all equipment and comply with provisions of NFPA 79 Electrical Standard for Industrial Machinery regarding electrical controls.
 2. Locate controls to facilitate operator safety and efficiency.
 3. Wherever possible, group electrical controls in a factory fabricated NEMA approved control panel in accordance with the National Electrical Code. Unless specified otherwise, provide NEMA 12 enclosures for indoor units and NEMA 4 enclosures for outdoor units.
 4. Contractor is responsible for correctly sizing starters, controllers, and start stop stations.
 5. Identify switches, pilot lights, and other controls with legend plates.
 6. Construct the plates from laminated polyvinyl-chloride plastic with appropriate legends engraved. The size of letters, color, and legend shall be submitted for approval.
 7. Mount legend plates onto the equipment in a manner approved by the Owner.
 8. Provide electrical identification in accordance with NFPA 79 Electrical Standard for Industrial Machinery.

9. No decals will be acceptable.
- O. Disconnect Switches:
 1. For starter and disconnect requirements, refer to Division 26.
 2. Equipment supplier to provide properly sized disconnect switches for each equipment item requiring electric power in accordance with manufacturer's requirements and NFPA 79 Electrical Standard for Industrial Machinery.
 3. Permanently label each disconnect switch to identify corresponding equipment item; labeling method shall be subject to approval of the Owner.
 4. Power connections, including wiring to controllers and starters shall be made per the Electrical Drawings and Division 26 Specifications.
 5. Provide with electric fusible disconnecting means, sized, and fused as required for each equipment item. Fuse all disconnect switches with 200,000 amp limiter fuses.
 6. Provide 120 volt equipment with electric thermal overload disconnecting means in accordance with Division 26 and sized as required for each equipment item.
- P. Electric Motors:
 1. Provide UL labeled high efficiency electrical motors suitable to operate on the electrical service indicated, and built and tested according to NEMA MG-1, MG-2, and MG-10; ANSI C50.10; IEEE 112; and ANSI/UL 674.
 2. Rate electric motor horsepower at 40°C ambient temperature with service factors in accordance with NEMA MG-1 for motors one horsepower and smaller and a service factor of 1.15 for motors rated over one horsepower up to and including 200 horsepower.
 3. Motors rated one horsepower or greater shall have a full-load power factor of 85 percent or higher.
 4. Motors rated 25 horsepower and greater shall be designed for reduced voltage starting.
 5. Provide motors with epoxy encapsulated insulation for severe usage in a corrosive atmosphere.
 6. Provide sliding motor bases where adjustable motor drive pulleys are used.
- Q. Motor Drive Pulleys:
 1. Provide adjustable motor drive pulleys where belt drives are used.
 2. Replace pulleys if necessary to properly operate the equipment.
- R. Guards: Provide guards for each coupling and belt drive in accordance with OSHA standards and other applicable codes.

PART 2 PRODUCTS

2.01 (NONE USED)

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the proposed location for the equipment including the working envelope around equipment and verify that sufficient space is available to both install and operate the equipment.
- B. Field check for clearances and interferences before fabrication and installation and relocate material and/or equipment furnished as required to eliminate interferences.
- C. Verify that foundations, holes, utilities, and slabs can accommodate equipment.
- D. Notify the Owner of any discrepancy or constraint before fabrication and delivery of the item to the site.
- E. Surfaces to receive equipment shall be sound, square, and true. Such surfaces shall be examined prior to installation of the equipment for defects that might impair the operability or shorten the life of any of the parts of the item.

3.02 PREPARATION

- A. Transmit submittals and deliverables required by this Section.
- B. Furnish products as indicated.
- C. Ensure substrates are in suitable condition to receive the work of this Section.
- D. Coordinate the installation of equipment with other trades and with the Owner to ensure that disruption to shop operations is kept to a minimum.
- E. Eliminate deficiencies discovered in surfaces and structures and prepare surfaces to receive equipment.
- F. Provide concrete foundations for equipment as recommended by the manufacturer for proper operation of the equipment, or as indicated on the Contract Drawings or as specified herein.
- G. Provide framing, inserts, flashings, holes, and openings as required to accommodate the equipment and the associated utility services, and as approved by the Owner.
- H. Install framing, concrete inserts, and flashings as required.
- I. Use dustless method to core drill holes in existing work.
- J. Grout holes in concrete walls and in floor, ceiling, and roof slabs to completely and neatly seal the openings after installation of equipment.

3.03 PRE-SHIPMENT INSPECTION AND TESTING

- A. The Owner shall reserve the rights to witness any equipment prior to shipment. The Contractor shall make the equipment ready for a comprehensive pre-shipment inspection and testing as requested.
- B. The Contractor shall prepare and submit for Owner approval a schedule and comprehensive procedure for functional testing and inspection. The submittal shall include step-by-step procedures, pass/fail criteria, all referenced documentation, and any other information necessary to successfully demonstrate that the equipment functions as intended.
- C. It is at the Owner's discretion to witness tests on a case-by-case basis.
- D. The equipment shall be laid-out in its final configuration to allow for all performance and functionality to be observed before shipment.
- E. Any issues or discrepancies identified during the pre-shipment inspection and testing shall be documented in a written report, prepared by the Contractor, detailing the issues or discrepancies identified and the Contractor's proposed corrective actions. This report shall be submitted to the Owner and approved by the Owner before corrective actions may be implemented. All issues or discrepancies identified shall be resolved before the equipment is shipped to the Owner.
- F. The Contractor shall bear all expenses of all tests, including the furnishing of all necessary instruments, lubricants, hydraulic fluids, supplies, data recorders, and operating personnel.
- G. The Owner will provide all vehicle components required for the tests. The Contractor shall provide shipping of required vehicle components to and from the Owner facility and the location of the tests.

3.04 INSTALLATION

- A. Do not proceed with installation until building and utility work conforms to project requirements.
- B. Furnish common and skilled labor, tools, rigging equipment, scaffolding, lifts, shims, dowels, and other materials to make complete installation of equipment specified and as shown on drawings.
 - 1. Use workers skilled in their respective trades who are also experienced installers of the type of equipment furnished.
 - 2. Actively promote cooperation between trades to facilitate execution of the Work.
 - 3. Perform all work in a neat and workmanlike manner.

- C. Set and align equipment in accordance with manufacturer's recommendations, approved shop and working drawings, specified codes, and applicable standards of trade practice.
 - 1. Set equipment true and level; make horizontal lines level and vertical lines plumb, demonstrate adequate leveling of installed equipment.
 - 2. Furnish and install grout, shim material, and miscellaneous steel necessary for brackets, anchors, or supports required to install equipment. Grout as necessary to stabilize equipment bases. Provide hard rubber shims and dampening pads as recommended by the equipment manufacturer for leveling of equipment and dampening of equipment vibration transmission.
- D. Reassemble equipment items which were dismantled for shipment or moving. Assemble items which are delivered knocked down or disassembled.
- E. Perform field machining required to install or fit equipment together.
- F. Check motors and drives carefully for correct rotation and alignment before placing into service or testing.
- G. Disconnect and realign couplings before placing into service or testing.
- H. Retighten bolted connections after installation.
- I. Adjust speeds subject to approval by the Owner. Adjust belt drives and replace worn belts in sets.
- J. Lubricate equipment where required before start-up.
- K. Perform mechanical and electrical Work required to install equipment in conformance with authorities having jurisdiction and the current codes and standards of practice employed by these trades.
- L. Clean fabricated assemblies and equipment thoroughly before and after operating.
- M. Details listed in these specifications are provided to give a general understanding of the Work, but do not limit the amount of Work or relieve the Contractor of additional Work which may be required for a complete installation.

3.05 INSPECTION

- A. Work will be inspected by the Owner periodically during the course of construction.
- B. Provide for inspections by all others having jurisdiction over the work performed under Section 41 22 13.13.

3.06 EQUIPMENT TEST AND CHECKOUT

- A. Before Final Acceptance, the equipment shall be tested in the presence of the Owner and demonstrated to the Owner's satisfaction to be correctly connected and installed and operates properly, as well as to demonstrate the equipment performs the work for which it is intended.
- B. The equipment shall be fully tested in accordance with the Contractor's test criteria as well as the test criteria identified in the individual specification sections herein.
- C. The Contractor shall prepare and submit for Owner approval a schedule and comprehensive procedure for functional testing, checkout, and inspection which includes the requirements of the individual sections. The submittal shall include step-by-step procedures, pass-fail criteria, all reference documentation, and any other information necessary to perform successful demonstration of the intended operation procedure(s).
- D. Arrange for inspections and tests required by governing agencies.
- E. Submit a testing schedule and procedure to the Owner for approval a minimum of 4 weeks prior to the start of the equipment test and checkout.
- F. Testing and checkout procedures of the Contractor shall be carried out completely.
- G. Tested equipment found to be defective or inoperable to any extent shall be reported to the Owner immediately. A complete written report of such defect or inoperability shall be provided no later than 2 days after the subject test is performed.

- H. Any operating difficulty or defective item shall be repaired or replaced and put into proper operation by the Contractor immediately, at no additional expense to the Owner.
- I. It shall be the Contractor's responsibility to safely test the equipment and to protect the neighboring equipment and surrounding areas from any potential damage resulting from testing operations. Cleanup of spills or leakage as well as repair to the equipment or surrounding areas directly resulting from the testing shall be the Contractor's responsibility.
- J. The Contractor shall bear all expenses of all tests, including the furnishing of all necessary instruments, lubricants, hydraulic fluids, supplies, data recorders, and operating personnel.
- K. Repeat any test at no additional cost to the Owner when directed to do so by the Owner.

3.07 SPECIAL TOOLS AND EQUIPMENT

- A. Contractor shall furnish any and all special or customized tools and/or devices. Equipment that the Owner requires for proper operation and maintenance of any supplied equipment prior to equipment acceptance.

3.08 SPARE PARTS

- A. Any and all consumable components and/or spare parts that might require replacement after testing the equipment shall be supplied prior to final equipment acceptance. Components and spare part with lead times greater than 6 months shall be identified on the equipment Bill of Materials.

END OF SECTION

**SECTION 11 52 23
TELEVISION MOUNTS****PART 1 GENERAL****1.01 SUMMARY**

- A. Section Includes:
 - 1. Wall mounts for flat panel televisions..

1.02 REFERENCES

- A. Underwriters Laboratories (UL), Inc: UL 1678 - Household, Commercial, and Professional-Use Carts and Stands.

1.03 SUBMITTALS

- A. Product Data: Provide data for mounts, mounting hardware, and other accessories..
- B. Shop Drawings: Indicate dimensions, structural support, mounting heights, attachment methods, and bracing..
- C. Specimen Warranty.
- D. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Government's name and registered with manufacturer.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Wall mounts shall be certified by Underwriters Laboratory (UL), for mounting to wood and steel framed construction.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Peerless Industries, Inc.: www.peerlessmounts.com
 - 1. SF650P for 37" to 75" displays.
- B. Da-Lite Screen Company, Inc.
- C. Draper, Inc..
- D. Or approved equal.

2.02 WALL MOUNTED TELEVISION BRACKET

- A. Wall mount constructed of heavy gauge cold rolled steel channel, rails and hangers with security lock. The mounting assembly shall be sized to hold television sizes as noted on drawings.
- B. Finish: Black powder paint coating.
- C. Mounting hardware:
 - 1. Fasteners: 3/8 inch minimum diameter of type, size, and spacing recommended by manufacturer to comply with UL requirements.
 - 2. Provide manufacturer's recommended hardware kit for attachment to metal stud substrate wall mounting plate.

2.03 ACCESSORIES

- A. Installation hardware: Provide attachment hardware, fasteners, and other components of type, size, and spacing recommended by manufacturer for complete functional, secure installation of mounts.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verification of Conditions: Verify that substrate surfaces including any required blocking are ready to receive work.

3.02 COORDINATION

- A. Coordinate provision of mounts with type, size, and weight of monitor to be used. Ensure requirements are compatible.
- B. Coordinate requirements for blocking, wall plates, bracing, and auxiliary structural supports to ensure adequate means for attachment of mounts.

3.03 INSTALLATION

- A. Install mounts in accordance with approved shop drawings and manufacturer's installation instructions.

3.04 TOLERANCES

- A. Maximum Offset From True Alignment: 1/2 inch across the total bracket length.

3.05 ADJUSTING

- A. Adjust mounts for smooth operation.

3.06 PROTECTION

- A. Protect mounts after installation from damage from construction operations. Remove and replace damaged units.

END OF SECTION

**SECTION 12 32 00
MANUFACTURED WOOD CASEWORK**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Manufactured standard casework, with cabinet hardware.

1.02 REFERENCE STANDARDS

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition.
- B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards.
- C. BHMA A156.9 - Cabinet Hardware.
- D. NEMA LD 3 - High-Pressure Decorative Laminates.

1.03 SUBMITTALS

- A. Product Data: Component dimensions, configurations, construction details, joint details, attachments.
- B. Shop Drawings: Indicate casework types, sizes, and locations, using large scale plans, elevations, and cross sections. Include rough-in and anchors and reinforcements, placement dimensions and tolerances, clearances required, and keying information.
- C. Samples for Finish Selection: Fully finished, for color selection. Minimum sample size: 2 inches by 3 inches.
 - 1. Plastic laminate samples, for color, texture, and finish selection.
- D. Maintenance Data: Manufacturer's recommendations for care and cleaning.
- E. Finish touch-up kit for each type and color of materials provided.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience and approved by manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect items provided by this section, including finished surfaces and hardware items during handling and installation. For metal surfaces, use polyethylene film or other protective material standard with the manufacturer.
- B. Acceptance at Site:
 - 1. Do not deliver or install casework until the conditions specified under Part 3, Examination Article of this section have been met. Products delivered to sites that are not enclosed and/or improperly conditioned will not be accepted if warping or damage due to unsatisfactory conditions occurs.
- C. Storage:
 - 1. Store casework in the area of installation. If necessary, prior to installation, temporarily store in another area, meeting the environmental requirements specified under Part 3, "Site Verification of Conditions" Article of this section.

PART 2 PRODUCTS**2.01 CASEWORK, GENERAL**

- A. Quality Standard: AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Plastic Laminate Faced Cabinets: Custom Grade.

2.02 FABRICATION

- A. Assembly: Shop assemble casework items for delivery to site in units easily handled and to permit passage through building openings.
- B. Construction: As required for selected grade.
- C. Structural Performance: Safely support the following minimum loads:
 - 1. Base Units: 500 pounds per linear foot across the cabinet ends.
 - 2. Drawers: 125 pounds, minimum.
 - 3. Shelves: 100 pounds, minimum.
- D. Fittings and Fixture Locations: Cut and drill components for fittings and fixtures.
- E. Hardware Application: Factory-machine casework members for hardware that is not surface applied.
- F. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.
- G. Scribes and Fillers: Panels of matching construction and finish, for locations where cabinets do not fit tight to adjacent construction.

2.03 PLASTIC-LAMINATE-CLAD CASEWORK

- A. Plastic-Laminate-Clad Casework: Solid wood and wood panel construction; each unit self-contained and not dependent on adjacent units or building structure for rigidity; in sizes necessary to avoid field cutting except for scribes and filler panels. Include adjustable levelers for base cabinets.
 - 1. Style: Flush overlay. Ease doors and drawer fronts slightly at edges.
 - 2. Cabinet Nominal Dimensions: Unless otherwise indicated, provide cabinets of widths and heights indicated on drawings, and with following front-to-back dimensions:
 - a. Base Cabinets: 22 inches.
 - 3. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline.
 - a. Finish: Matte or suede, gloss rating of 5 to 20.
 - b. Surface Color and Pattern: As selected by Contracting Officer or Contracting Officer's Representative from manufacturer's full line.
 - c. Exposed Interior Surfaces: Thermally fused laminate.
 - 1) Color: White.

2.04 COUNTERTOPS

- A. Countertops: See Section 12 36 00.

2.05 CABINET HARDWARE

- A. Manufacturer's standard types, styles and finishes.
- B. Comply with BHMA A156.9 requirements.

2.06 MATERIALS

- A. Wood-Based Materials:
 - 1. Solid Wood: Air-dried to 4.5 percent moisture content, then tempered to 6 percent moisture content before use.
 - 2. Composite Wood Panels: Containing no urea-formaldehyde resin binders.
- B. Solid Wood: Clear, dry, sound, plain sawn, selected for compatible species, grain and color, no defects.
- C. Concealed Solid Wood or Plywood: Any species and without defects affecting strength or utility.
- D. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications. complying with Grade requirements, and standard with the manufacturer.

2.07 ACCESSORIES

- A. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.
- B. Sealant for Use in Casework Installation:
 - 1. Manufacturer's recommended type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Site Verification of Environmental Conditions:
 - 1. Do not deliver casework until the following conditions have been met:
 - a. Building has been enclosed (windows and doors sealed and weather-tight).
 - b. An operational HVAC system that maintains temperature and humidity at occupancy levels has been put in place.
 - c. Ceiling, overhead ductwork, piping, and lighting have been installed.
 - d. Installation areas do not require further "wet work" construction.
- B. For Base Cabinets Installation: Examine floor levelness and flatness of installation space. Do not proceed with installation if encountered floor conditions required more than 1/2 inch leveling adjustment. When installation conditions are acceptable, for each space, establish the high point of the floor. Set and make level and plumb first cabinet in relation to this high point.
- C. Verify adequacy of support framing and anchors.
- D. Verify that service connections are correctly located and of proper characteristics.

3.02 INSTALLATION

- A. Perform installation in accordance with manufacturer's instructions.
- B. Use anchoring devices to suit conditions and substrate materials encountered. Use concealed fasteners to the greatest degree possible. Use exposed fasteners only where allowed by approved shop drawings, or where concealed fasteners are impracticable.
- C. Set casework items plumb and square, securely anchored to building structure.
- D. Align cabinets to adjoining components, install filler and/or scribe panels where necessary to close gaps.
- E. Fasten together cabinets in continuous runs, with joints flush, uniform and tight. Misalignment of adjacent units not to exceed 1/16 inch. In addition, do not exceed the following tolerances:
 - 1. Variation of Tops of Base Cabinets from Level: 1/16 inch in 10 feet.
 - 2. Variation of Faces of Cabinets from a True Plane: 1/8 inch in 10 feet.
 - 3. Variation of Adjacent Surfaces from a True Plane (Lippage): 1/32 inch.
 - 4. Variation in Alignment of Adjacent Door and Drawer Edges: 1/16 inch.
- F. Base Cabinets: Fasten cabinets to service space framing and/or wall substrates, with fasteners spaced not more than 16 inches on center. Bolt adjacent cabinets together with joints flush, tight, and uniform.
- G. Install hardware uniformly and precisely.
- H. Countertops: Install countertops intended and furnished for field installation in one true plane, with ends abutting at hairline joints, and no raised edges.
- I. Replace units that are damaged, including those that have damaged finishes.

3.03 ADJUSTING

- A. Adjust operating parts, including doors, drawers, hardware, and fixtures to function smoothly.

3.04 CLEANING

- A. Clean casework and other installed surfaces thoroughly.

3.05 PROTECTION

- A. Do not permit finished casework to be exposed to continued construction activity.
- B. Protect casework and countertops from ongoing construction activities. Prevent workmen from standing on, or storing tools and materials on casework or countertops.
- C. Repair damage, including to finishes, that occurs prior to Date of Substantial Completion, using methods prescribed by manufacturer; replace units that cannot be repaired to like-new condition.

END OF SECTION

**SECTION 12 36 00
COUNTERTOPS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Countertops for architectural cabinet work.
- B. Wall-hung counters and vanity tops.

1.02 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- B. ISFA 2-01 - Classification and Standards for Solid Surfacing Material.
- C. NEMA LD 3 - High-Pressure Decorative Laminates.
- D. PS 1 - Structural Plywood.

1.03 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Specimen warranty.
- B. Shop Drawings: Complete details of materials and installation ; combine with shop drawings of cabinets and casework specified in other sections.
- C. Selection Samples: For each finish product specified, color chips representing manufacturer's full range of available colors and patterns.
- D. Test Reports: Chemical resistance testing, showing compliance with specified requirements.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.05 FIELD CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS**2.01 COUNTERTOPS**

- A. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
 - 1. Flat Sheet Thickness: 1/2 inch, minimum.
 - 2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - a. Manufacturers:
 - 1) Dupont: www.corian.com/#sle.
 - 2) Formica Corporation: www.formica.com/#sle.
 - 3) Meganite, Inc: www.meganite.com/#sle.
 - 4) Wilsonart: www.wilsonart.com/#sle.
 - b. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - c. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.

- d. Color and Pattern: As selected by Contracting Officer or Contracting Officer's Representative from manufacturer's standard line.
3. Other Components Thickness: 1/2 inch, minimum.
4. Exposed Edge Treatment: Built up to minimum 1-1/4 inch thick; square edge; use marine edge at sinks.
5. Back and End Splashes: Same sheet material, radiused top; minimum 4 inches high.
6. Skirts: As indicated on drawings.
7. Fabricate in accordance with manufacturer's standard requirements.

2.02 MATERIALS

- A. Wood-Based Components:
 1. Wood fabricated from old growth timber is not permitted.
- B. Plywood for Supporting Substrate: PS 1 Exterior Grade, A-C veneer grade, minimum 5-ply; minimum 3/4 inch thick; join lengths using metal splines.
- C. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.
- D. Joint Sealant: Mildew-resistant silicone sealant, white.

2.03 ACCESSORIES

- A. Fixed Top-Mounted Countertop Support Brackets:
 1. Material: Steel.
 2. Finish: Manufacturer's standard, factory-applied, textured powder coat.
 3. Color: Black.
 4. Products:
 - a. Centerline Brackets; Front Mounting Countertop Support:
www.countertopbracket.com/#sle.
 - b. Or approved equal.

2.04 FABRICATION

- A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
 1. Join lengths of tops using best method recommended by manufacturer.
 2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
 3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
- B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
 1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
 2. Height: 4 inches, unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Install vanities in accordance with manufacturer's instructions and approved shop drawings

- B. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- C. Apply sealer products in accordance with manufacturer's written instructions.
- D. Seal joint between back/end splashes and vertical surfaces.

3.04 TOLERANCES

- A. Variation From Horizontal: 1/8 inch in 10 feet, maximum.
- B. Offset From Wall, Countertops: 1/8 inch maximum; 1/16 inch minimum.
- C. Field Joints: 1/8 inch wide, maximum.

3.05 CLEANING

- A. Clean countertops surfaces thoroughly.

3.06 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 12 48 13
ENTRANCE FLOOR MATS AND FRAMES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Extruded aluminum entrance floor grilles.

1.02 SUBMITTALS

- A. Product Data: Provide data indicating properties of walk-off surface, component dimensions and recessed frame characteristics.
- B. Samples: Submit two samples, 1 by 2 inches in size illustrating pattern, color, finish, and edging.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Entrance Floor Grilles and Gratings:
 - 1. Activar Construction Products Group - JL Industries: www.activarcpg.com/#sle.
 - 2. Babcock-Davis: www.babcockdavis.com/#sle.
 - 3. Construction Specialties, Inc; PediTred G3: www.c-sgroup.com/#sle.
 - 4. Kadee Industries: www.kadeeindustries.com/#sle.
 - 5. Reese Enterprises, Inc: www.reeseusa.com/#sle.
 - 6. Or approved equal.

2.02 ENTRANCE FLOOR GRILLES AND GRATINGS

- A. Entrance Floor Grilles: Recessed extruded aluminum grille assembly with nominal 1 inch wide tread strips running perpendicular to traffic flow, slots between treads, and perimeter frame forming sides of recess; grille hinged for access to recess.
 - 1. Recess Depth: 1/2 inches.
 - 2. Tread Surfaces: Nylon carpet.
 - 3. Colors: As selected by Contracting Officer or Contracting Officer's Representative from manufacturer's standard selection.
 - 4. Length in Direction of Traffic Flow: 72 inches.
 - 5. Width Perpendicular to Traffic Flow: Full width of entrance door opening.
 - 6. Frame: Anodized aluminum for embedding in concrete; minimal exposed trim; stud or hook concrete anchors.
- B. Mounting: Top of non-resilient members level with adjacent floor.
- C. Structural Capacity: Capable of supporting rolling load of 750 lb without permanent deformation or noticeable deflection.
- D. Vibration Resistant Fabrication: Welded, riveted, or bolted members; no snap or friction connections.

2.03 FABRICATION

- A. Construct recessed mat frames square, tight joints at corners, rigid. Coat surfaces with protective coating where in contact with cementitious materials.
- B. Fabricate mats in single unit sizes; fabricate multiple mats where indicated on drawings.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that floor opening for mats are ready to receive work.

3.02 PREPARATION

- A. Mats: Verify size of floor recess before fabricating mats.
- B. Vacuum clean floor recess.

3.03 INSTALLATION

- A. Install frames to achieve flush plane with finished floor surface.
- B. Install walk-off surface in floor recess flush with finish floor after cleaning of finish flooring.

3.04 TOLERANCES

- A. Maximum Gap Formed at Recessed Frame From Mat Size: 1/4 inch.

END OF SECTION

SECTION 13 46 13
LIGHTNING PROTECTION FOR STRUCTURES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Strike (air) terminals and interconnecting conductors.
- B. Grounding and bonding for lightning protection.

1.02 RELATED REQUIREMENTS

- A. Surge Protection for Wiring Systems: Specified in individual system requirements.

1.03 REFERENCE STANDARDS

- A. NFPA 780 - Standard for the Installation of Lightning Protection Systems.
- B. UL 96 - Lightning Protection Components.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination with Concrete Work: Coordinate embedding of lightning protection components in concrete.
- B. Coordination with Roofing Work: Ensure adequate attachment of strike terminals and conductors without damage to roofing.
- C. Preinstallation Meeting: Convene meeting at least at least two weeks prior to commencement of work affected by lightning protection system requirements to discuss prerequisites and coordination required by other installers; require attendance by representatives of installers whose work will be affected.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate location and layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details.
 - 1. Where conductors or grounds are to be embedded or concealed in other construction, submit shop drawings at least 30 days prior to start of construction.
 - 2. If concrete-encased grounds are to be used and are not shown in Contract Documents, provide sufficient data to determine concrete encasement dimensions and location.
 - 3. Include data on actual ground resistance determined by field measurement in accordance with NFPA 780.
 - 4. Include engineering analysis of equalization of potential to metal bodies within structure.
- C. Product Data: Provide dimensions and materials of each component, indication of testing agency listing, and installation instructions.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Installation Certification: Submit copy of certification agency's approval.
- F. Operation and Maintenance Data: Provide recommended inspection and testing plan, including recommended intervals, to achieve periodic maintenance as recommended in NFPA 780; provide customized plan reflecting actual installation configuration with specific installed components identified.
- G. Project Record Documents: Record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors in project record documents.

1.06 QUALITY ASSURANCE

- A. Maintain one copy of each referenced system design standard on site.
- B. Manufacturer Qualifications: Company specializing in lightning protection equipment with minimum three years documented experience.

- C. Designer Qualifications: Person or entity, employed by installer, who specializes in lightning protection system design with minimum three years documented experience.
- D. Installer Qualifications: Capable of providing specified certification of installed system.
- E. Products: Listed, classified, and labeled as suitable for purpose intended.
- F. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Lightning Protection Components:
 - 1. Advanced Lightning Technology (ALT): www.altfab.com/#sle.
 - 2. Harger Lightning and Grounding: www.harger.com/#sle.
 - 3. National Lightning Protection Corporation: www.theprotectionsource.com/#sle.
 - 4. Robbins Lightning, Inc: www.robblinslightning.com/#sle.
 - 5. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.
 - 6. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 LIGHTNING PROTECTION SYSTEM

- A. Lightning Protection System: Provide complete system complying with NFPA 780, including air terminals, bonding, interconnecting conductors and grounding electrodes.
 - 1. Provide system that protects:
 - a. Entire structure.
 - b. Open air areas within 100 feet of exterior walls at grade level.
 - c. Open air areas within building footprint.
 - 2. Coordinate with other grounding and bonding systems specified.
 - 3. Determine ground resistance by field measurement.
 - 4. Provide copper, bronze, or stainless steel components, except where aluminum is allowed by NFPA 780.
 - 5. Provide system certified by Underwriters Laboratories or Lightning Protection Institute.
- B. Strike Terminals: Provide strike (air) terminals on the following:
 - 1. Roofs.
 - 2. Penthouse roofs.
 - 3. Roof mounted equipment.

2.03 COMPONENTS

- A. All Components: Complying with applicable requirements of UL 96.
- B. Strike (Air) Terminals: Aluminum, solid, with adhesive bases for single-ply roof installations.
- C. Grounding Rods: Solid copper.
- D. Ground Plate: Copper.
- E. Conductors: Copper cable.
- F. Connectors and Splicers: Aluminum.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated on shop drawings.
- B. Coordinate work with installation of roofing and exterior and interior finishes.

3.02 INSTALLATION

- A. Install in accordance with referenced system standards and as required for specified certification.

- B. Connect conductors using mechanical connectors or exothermic welding process; protect adjacent construction elements and finishes from damage.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Perform visual inspection as specified in NFPA 780 as if this were a periodic follow-up inspection.
- C. Perform continuity testing as specified in NFPA 780 as if this were testing for periodic maintenance.
- D. Obtain services of specified certification agency to provide inspection and certification of lightning protection system, including performance of other testing required by that agency.

END OF SECTION

SECTION 14 21 23
ELECTRIC TRACTION PASSENGER ELEVATORS

PART 1 – GENERAL**1.01 SECTION INCLUDES**

- A. Electric traction passenger elevators.

1.02 REFERENCE STANDARDS

- A. ASME A17.1 - Safety Code for Elevators and Escalators.
- B. ISO 9001 - Quality Management Systems — Requirements.
- C. NFPA 70 - National Electrical Code.
- D. NFPA 80 - Standard for Fire Doors and Other Opening Protectives.
- E. UL 10B - Standard for Fire Tests of Door Assemblies.

1.03 DESIGN REQUIREMENTS

- A. Arrange elevator components in control closet or machinery space so equipment can be removed for repairs or replaced with minimal disturbance to other equipment and components.
- B. Where permitted by code, provide all elevator equipment including controls, drives, transformers, and rescue features within the elevator hoistway.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer/installer's product data, including,
 - 1. Descriptive brochures and detail drawings of car and hall fixtures, cab ceilings, and product features.
 - 2. Power Information: Horsepower, starting current, running current, machine and control heat release, and electrical requirements.
- B. Shop Drawings: Submit manufacturer/installer's shop drawings, including plans, elevations, sections, and details, indicating location of equipment, loads, dimensions, tolerances, materials, components, fabrication, fasteners, hardware, finish, options, accessories, and other information to render totally functional elevators.
- C. Samples: Submit manufacturer/installer's samples of standard colors and finishes of finish materials.
- D. Operation and Maintenance Manual: Submit manufacturer/installer's operation and maintenance manual; including operation, maintenance, adjustment, and cleaning instructions; trouble shooting guide; renewal parts catalogs; and electrical wiring diagrams.
- E. Warranty: Submit manufacturer/installer's standard warranty.

1.05 QUALITY ASSURANCE

- A. Manufacturer/Installer's Qualifications: Specialize in manufacturing and installing elevator equipment, with a minimum of 10 years experience.
- B. Regulatory Requirements:
 - 1. Elevator design, clearances, construction, workmanship, materials, and installation, unless specified otherwise, shall be in accordance with ANSI/ASME A17.1, handicap accessibility, Americans with Disabilities Act, and other codes having legal jurisdiction.
 - 2. ANSI/ASME A17.1 shall govern, except where codes having legal jurisdiction include more rigid requirements or conflict with ANSI/ASME A17.1.
 - 3. Elevator shall follow design and manufacturing procedures certified in accordance with ISO 9001-2000 to meet product and service requirements for quality assurance for new products.
 - 4. Where product is in variance to the published ANSI/ASME A17.1 model code, provide a 3rd party AECO certification demonstrating equivalent function, safety, and performance.
- C. Pre-installation Meeting:

1. Convene pre-installation meeting before start of installation of elevators.
2. Require attendance of parties directly affecting work of this section, including Contractor, and elevator installer.
3. Review examination, installation, field quality control, adjusting, cleaning, protection, and coordination with other work.

1.06 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer/installer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer/installer.
- B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer/installer's instructions.
- C. Handling: Protect materials during handling and installation to prevent damage.

1.07 PROJECT CONDITIONS

- A. Temporary Electrical Power:
 1. Provide temporary 220 VAC, single-phase, 60 Hz., GFCI-protected electricity for installation of elevator components.
- B. Installation of the Elevator:
 1. Provide permanent three-phase power prior to installation start.
- C. Temporary Use of Elevator:
 1. Temporary use of elevator shall be in accordance with terms and conditions of manufacturer/installer's temporary acceptance form.

1.08 SCHEDULING

- A. Coordinate elevator work with work of other trades, for proper time and sequence to avoid construction delays.

1.09 WARRANTY

- A. Manufacturer/installer shall guarantee materials and workmanship of equipment installed under these specifications and make good, defects not due to ordinary wear or to improper use, which may develop within 1 year after completion of installation or acceptance thereof by beneficial use, whichever is earlier.

1.10 MAINTENANCE SERVICE

- A. Elevator maintenance service shall be performed by elevator manufacturer/installer.
- B. Elevators shall receive regular maintenance on each unit for period of 12 months after completion of work specified herein or acceptance thereof by beneficial use, whichever is earlier.
- C. Trained employees shall make periodic examinations and perform work including necessary adjusting, greasing, oiling, and replacing parts to keep elevators in operation, except parts that require replacement because of accidents, vandalism, misuse, or negligence by parties other than manufacturer/installer.
- D. Manufacturer/installer shall perform all Work, except emergency minor adjustment call-back service, during regular working hours. Manufacturer/installer shall provide emergency minor adjustment call-back service, during regular working hours.
- E. Maintenance Options
 1. Regular Maintenance: During Regular Working Hours
 2. Callback Service: During Regular Working Hours
 3. Maintenance Period: 12 months

PART 2 – PRODUCTS

2.01 MANUFACTURER/INSTALLER

- A. Schindler Elevator Corporation, Website www.us.schindler.com.

- B. Kone Corporation
- C. Otis Elevator Company
- D. TK Elevator
- E. Elevator shall be installed by elevator manufacturer.

2.02 ELEVATOR SYSTEM AND COMPONENTS

- A. Electric Traction Passenger Elevators: Basis of design is the Schindler 3100 Gearless Traction Elevator.
- B. Elevator Equipment Summary:
 - 1. Application: Machine Room Less (MRL)
 - 2. Counterweight Location: Side
 - 3. Machine Location: Top of the hoistway mounted on car and counterweight guide rails
 - 4. Control Space Location: Top landing entrance frame or entrance frame at one floor below the top landing
 - 5. Service: General Purpose Passenger
 - 6. Quantity: 1 Unit
 - 7. Capacity: 2100 lbs
 - 8. Speed: 100 fpm
 - 9. Travel: 14' 0"
 - 10. Landings: 2
 - 11. Front Openings: 2
 - 12. Rear Openings: 0
 - 13. Rear Door Hand: N/A
 - 14. Operation: Microprocessor Single Car Automatic Operation
 - 15. Clear Inside Dimensions: 5' 9-5/16" Wide X 4' 4-7/8" Deep
 - 16. Cab Height: 7' 9"
 - 17. Guide Rails: Equivalent to 12 lb. per foot
 - 18. Entrance Type and Width: Two Speed Side Opening 3' 0" Wide X 7' 0" High doors
 - 19. Entrance Height: 7'-0"
 - 20. Power Supply: 480 Volts 3 Phase 60 Hz
- C. Performance:
 - 1. Car Speed: -10% to +5% of contract speed under any loading condition or direction of travel.
 - 2. Car Capacity: Safely lower, stop and hold up to 125% of rated load per code.
- D. Ride Quality:
 - 1. Vertical Vibration (maximum): 25 mg
 - 2. Horizontal Vibration (maximum): 15 mg
 - 3. Vertical Jerk (maximum): 2 ft/sec³
 - 4. Acceleration (maximum): 1.6 ft/sec²
 - 5. In Car Noise: 53-60 dB(A)
 - 6. Stopping Accuracy: ±5mm
 - 7. Starts per hour (maximum): 180
- E. Elevator Operation:
 - 1. Simplex Collective Operation: Using a microprocessor based controller, operation shall be automatic by means of the car and hall buttons. When all calls have been answered, the car shall park at the last landing served.
 - 2. Group Automatic Operation with Demand-Based Dispatching: Provide reprogrammable group automatic system that assigns cars to hall calls based on a dispatching algorithm designed to minimize passenger waiting time.
- F. Operating Features - Standard:
 - 1. Door Light Curtain Protection

2. Static AC Drive
3. Phase Monitor Relay
4. Cab Overload with Indicator
5. Load-weighing
6. Central Alarm
7. Remote Monitoring
8. Firefighter's Operation
9. Automatic Evacuation
 - a. When the main line power is lost for longer than 5 seconds the emergency battery power supply provides power automatically to the elevator controller. If the car is at a floor when the power fails, it remains at that floor, opens its doors, and shuts down. If the car is between floors, it is raised or lowered to the first available landing, opens its doors, and shuts down.
10. Independent Service

G. Operating Features - Optional:

2.03 EQUIPMENT: CONTROL COMPONENTS AND CONTROL SPACE

- A. Controller: Provide microprocessor based control system to perform all of the functions of safe elevator operation, as well as perform car and group operational control.
 1. All high voltage (110v or above) contact points inside the inspection and test panel shall be protected from accidental contact in a situation where the access panels are open.
 2. The controller shall be distributed throughout the elevator system located in the overhead, cab and inspection and test panel. The inverter will be mounted in the overhead adjacent to the hoist machine and an inspection and test panel will be located in the door jamb at the top floor or one floor below the top floor. No elevator equipment mechanical rooms or closets are required.
 3. Provide multi-bus control architecture to reduce cabling, material and waste.
- B. Drive: Provide a Variable Voltage Variable Frequency AC Closed Loop drive system. Provide stable start without high peak current, quickly reaching a low energy consumption level.
- C. Inspection and Test Panel: Integrated control equipment, main inspection and test panel in door frame at top level served or at one floor below the top level served.

2.04 EQUIPMENT: HOISTWAY COMPONENTS

- A. Machine:
 1. Gearless asynchronous AC motor with integral drive sheave, service and emergency brakes.
 2. Design machine to enable direct power transfer, thereby avoiding loss of power.
 3. Design machine to be compact, lightweight and durable to optimize material usage and save space.
 4. Mount to structural support channels on top of guide rail system as applicable in hoistway overhead.
- B. Governor:
 1. Tension type over-speed governor with remote manual reset.
 2. Mount to structural support channels as applicable in hoistway overhead.
- C. Buffers, Car and Counterweight: Compression spring type buffers to meet code.
- D. Hoistway Operating Devices:
 1. Emergency Stop switch in the pit.
 2. Terminal stopping switches.
 3. Emergency stop switch on the machine.
- E. Positioning System: System consisting of proximity sensors and door zone vanes.

- F. Guide Rails and Attachments: Provide Tee-section steel rails with brackets and fasteners. Side counterweight arrangements shall have a dual purpose bracket that combines both counterweight guide rails, and one of the car guide rails to building fastening.
- G. Suspension System: Non circular Elastomeric coated suspension media with high tensile grade steel cords.
- H. Governor rope: Steel wire rope with 0.24 inch diameter.

2.05 EQUIPMENT: HOISTWAY ENTRANCES

- A. Hoistway Doors and Frames:
 - 1. UL rated with required fire rating.
 - 2. Doors: Rigid flush panel construction with reinforcement ribs.
 - 3. Frames: Securely fasten at corners to form unit frame. Frames shall be bolted.
- B. Finish:
 - 1. Exposed Areas of Corridor Frames: Painted Color - All Floors
 - 2. Exposed Areas of Corridor Frames:
 - a. 1st Floor: Painted Primer
 - b. 2nd Floor: Painted Primer
 - c. Typical Floors: Painted Primer
 - 3. Doors: Painted Color - All Floors
 - 4. Doors: Painted Color - All Floors
 - 5. Doors:
 - a. 1st Floor: Painted Primer
 - b. 2nd Floor: Painted Primer
 - c. Typical Floor: Painted Primer
 - 6. Sills: Aluminum - All Floors
 - 7. Sills: Aluminum - All Floors
- C. Entrance Markings and Jamb Plates: Provide standard entrance jamb tactile markings on both jambs, at all floors. Plate Mounting: Refer to manufacturer drawings.

2.06 EQUIPMENT: CAR COMPONENTS

- A. Car Frame and Safety: Provide car frame with adequate bracing to support the platform and car enclosure. The safety shall be integral to the car frame and shall be flexible guide clamp type.
- B. Platform: Provide platform of steel construction with plywood subfloor and aluminum threshold.
- C. Car Guides: Provide sliding guide shoes mounted to top and bottom of both car and counterweight frame. Arrange each guide shoe assembly to maintain constant contact on the rail surfaces. Provide retainers in areas with Seismic design requirements.
- D. Provide central guiding system to reduce mechanical friction and energy consumption.
- E. Steel Cab:
 - 1. Fire rating: Provide Class B fire rating for cab, or Class A fire rating where required by local Code.
 - 2. Design cab to comply with LEED Indoor Environmental Quality requirements through use of Low-Emitting Materials on walls, ceiling and subflooring.
 - 3. Car wall finish: Steel Painted Finish selected from manufacturer's standard selections.
 - 4. Base and frieze: Aluminum.
 - 5. Car front finish: Brushed stainless steel.
 - 6. Car door finish: Brushed stainless steel.
 - 7. Ceiling: Canopy ceiling, finished in #4 Stainless Steel With Down Lit Led Lighting. Provide lighting consisting of four compact fluorescent energy saving lights located in two semi-oval lateral cutouts located on the center-sides of the cab ceiling, Lexan lens cover.
 - 8. Handrail: Round Brushed Stainless Steel - Return End. Locate on Rear Wall.
 - 9. Flooring: By others. Not to exceed 3/8" finished depth.
 - 10. Ventilation: Provide one-speed fan in canopy.

11. Emergency Car Lighting: Provide an emergency power unit employing a 12 volt sealed rechargeable battery and static circuits to illuminate the elevator car and provide current to the alarm bell in the event of building power failure.
12. Emergency Siren: Provide siren mounted on top of the car that is activated when the Alarm button in the car operating panel is engaged.
13. Emergency Exit Switch: Provide an electrical contact to open the safety circuit when the emergency car top exit is opened. When the exit door is opened, the top exit switch shall signal the control and the car will be unable to move.
14. Emergency Exit Lock: Provide an emergency exit lock where required by local code.
15. Emergency Exit Guard: Provide emergency exit guard on top of car when required for hoistway wall to platform clearance exceeds 12" or for multiple cars in hoistway.

2.07 DOOR OPERATOR AND REOPENING DEVICES

- A. Door Operator: Provide a closed loop VVVF high performance door operator with frequency controlled drive for fast and reliable operation to open and close the car and hoistway doors simultaneously.
- B. In case of interruption or failure of electric power, the doors can be readily opened by hand from within the car, in accordance with applicable code. Provide emergency devices and keys for opening doors from the landing as required by local code.
- C. Doors shall open automatically when the car has arrived at or is leveling at the respective landings. Doors shall close after a predetermined time interval or immediately upon pressing of a car button. Provide door open button in the car operating panel. Momentary pressing of this button shall reopen the doors and reset the time interval.
- D. Provide door hangers and tracks for each car and hoistway door. Contour tracks to match the hanger sheaves. Design hangers for power operation with provisions for vertical and lateral adjustment. Hanger sheaves shall have polyurethane tires and pre-lubricated sealed for life bearings.
- E. Electronic Door Safety Device: Equip car doors with concealed transmitter and receiver infrared beam devices to detect presence of object in process of passing through hoistway entrance and car doorway (light curtain device).
 1. Use multi-beam scanning without moving parts to detect obstructions in door opening.
 2. Detector Device: Prevent doors from closing, or if they have already started closing, cause doors to reopen and remain open while object is within detection zone.
 3. Horizontal Beams: Minimum of 33 infra red beams to fill doorway from ground level to a height of 6 feet.

2.08 EQUIPMENT: SIGNAL DEVICES AND FIXTURES

- A. Car Operating Panel: Provide a car operating panel with all push buttons, key switches and message indicators for elevator operation.
 1. a. Full height car operating panel shall be surface-mounted on front return.
 2. Comply with handicap requirements.
 3. Push Buttons: Mechanical, illuminating using long-lasting LEDs for each floor served.
 4. Emergency Buttons: Provide in accordance with code. Emergency alarm button, door open and door close buttons.
- B. Features of the Car Operating Panel Shall Include:
 1. Audible chime to signal that the car is either stopping at or passing a floor served by the elevator.
 2. Raised markings and Braille provided to the left hand side of each push button.
 3. Car Lantern: Provide LED illuminated car lantern with direction arrows to comply with local code when hall lanterns are not provided.
 4. Door open and close push buttons.
 5. Firefighter's hat and Phase 2 Key-switch
 6. Inspection key-switch.

7. Key-switch for optional Independent Service Operation
 8. Illuminated alarm button with raised marking.
 9. Elevator Data Plate marked with elevator capacity and car number.
 10. Help Button: Activation of help button will initiate two-way communication between car and a location inside the building, switching over to alternate location if call is unanswered, where personnel are available to take the appropriate action. Visual indicators are provided for call initiation and call acknowledgement.
- C. Hall Fixtures: Provide hall fixtures with necessary push buttons and key switches for elevator operation.
1. Push buttons: Metallic tactile push buttons, up button and down button at intermediate floors, single button at each terminal floor.
 2. Height: Comply with handicap requirements.
 3. Illumination: Illuminating using long-lasting low power LEDs.
 4. Hall Lanterns and Position Indicators.
 - a. a. LED illuminated direction arrows with audible and visible call acknowledgement.
 5. Hoistway access switches: Provide key-switch at top and/or bottom floor in entrance jamb as required by local code.
 6. Firefighter's Phase 1 Service: Key switch in brushed stainless steel cover plate.
 7. Fixture Cover Plates: For push buttons, hall lanterns and position indicators, resistant white back-printed glass, no screws required for mounting. Provide stainless steel cover plates for Firefighter's Phase I switch and hoistway access switches, with tamper resistant screws in same finish.
 8. Mounting: Mount hall fixtures in entrance frames.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine hoistways, hoistway openings, and pits before starting elevator installation.
- B. Verify hoistway, pit, overhead, and openings are of correct size, within tolerances, and are ready for work of this section.
- C. Verify walls are plumb where openings occur and ready for entrance sill installation. Traditional sill angle or concrete sill support shall not be required.
- D. Verify hoistway is clear and plumb, with variations not to exceed -0 to at any point. Verify projections greater than 4" must be beveled not less than 75 degrees from horizontal. No negative tolerance is permitted for minimum hoistway dimensions.
- E. Verify minimum 1-hour fire-resistance rating of hatch walls.
- F. Notify Architect in writing of dimensional discrepancies or other conditions detrimental to proper installation or performance of elevators.
- G. Do not proceed with elevator installation until unsatisfactory conditions have been corrected in a manner acceptable to manufacturer/installer.

3.02 INSTALLATION

- A. Install elevators in accordance with manufacturer/installer's instructions and ANSI/ASME A17.1.
- B. Set entrances in vertical alignment with car openings, and aligned with plumb hoistway lines.

3.03 FIELD QUALITY CONTROL

- A. Perform tests of elevator as required by ANSI/ASME A17.1 and governing codes.

3.04 ADJUSTING

- A. Adjust elevators for proper operation in accordance with manufacturer/installer's instructions.
- B. Adjust elevators for smooth acceleration and deceleration of car so not to cause passenger discomfort.

- C. Adjust doors to prevent opening of doors at landing on corridor side, unless car is at rest at that landing, or is in leveling zone and stopping at that landing.
- D. Adjust automatic floor leveling feature at each floor to within 1/4 inch of landing.
- E. Repair minor damages to finish in accordance with manufacturer/installer's instructions and as approved by Architect.
- F. Remove and replace damaged components that cannot be successfully repaired as determined by Architect.

3.05 CLEANING

- A. Clean elevators promptly after installation in accordance with manufacturer/installer's instructions.
- B. Do not use harsh cleaning materials or methods that could damage finish.

3.06 PROTECTION

- A. Protect installed elevators from damage during construction in accordance with the negotiated temporary use agreement between Owner and manufacturer's installer.

END OF SECTION

SECTION 21 05 00**COMMON WORK RESULTS FOR FIRE-SUPPRESSION****PART 1 - GENERAL****1.1 SUMMARY**

A. The Work of this Section includes:

1. Sleeves without waterstop.
2. Sleeves with waterstop.
3. Sleeve-seal systems.
4. Grout.
5. Silicone sealants.
6. Escutcheons.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, include construction details, material descriptions, and dimensions of components.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS**2.1 SLEEVES AND SLEEVE SEALS**

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, 24 gauge minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.

B. Sleeves with Waterstop:

1. Description: Manufactured steel, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. Sleeve-Seal Systems:

1. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - a. Hydrostatic Seal: 20 psig minimum.
 - b. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
 - c. Pressure Plates: Carbon steel.
 - d. Connecting Bolts and Nuts: Carbon steel, with ASTM B633 coating of length required to secure pressure plates to sealing elements.

D. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000 psi, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

E. Silicone Sealants:

1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.
 - a. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.
2. Silicone Sealant, S, P, T, NT: Single-component, 25 or 100/50, pourable, plus 25 percent and minus 25 percent or plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.
 - a. Standard: ASTM C920, Type S, Grade P, Class 25 or Class 100/50, Uses T and NT.
3. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

2.2 ESCUTCHEONS

A. Escutcheon Types:

1. One-Piece, Steel Type: With polished, chrome-plated or polished brass finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.
3. One-Piece, Cast-Brass Type: With polished, chrome-plated or polished brass finish and setscrew fastener.

PART 3 - EXECUTION**3.1 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS**

- A. Install pipe loops and offsets in accordance with NFPA 13 requirements for expansion and contraction compensation.

3.2 INSTALLATION OF SLEEVES, GENERAL

- A. Install sleeves for piping passing through penetrations in partitions and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system. Select to maintain fire-resistance of slab and wall.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe.
 - 3. Seal annular space between sleeve and piping; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, and ceilings at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials.

3.3 INSTALLATION OF SLEEVES WITH WATERSTOP

- A. Install sleeve with waterstop as new walls and slabs are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width centered in concrete slab or wall.
- C. Secure nailing flanges to wooden concrete forms.
- D. Using grout or silicone sealant, seal space around outside of sleeves.

3.4 INSTALLATION OF SLEEVE-SEAL SYSTEMS

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and passing through exterior walls.

- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.5 INSTALLATION OF ESCUTCHEONS

- A. Install escutcheons for piping penetrations of walls and ceilings.
- B. Install escutcheons with ID to closely fit around pipe and with OD that completely covers opening.

3.6 FIELD QUALITY CONTROL

- A. Sleeves and Sleeve Seals:
 - 1. Perform the following tests and inspections:
 - a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
 - b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
 - 2. Prepare test and inspection reports.
- B. Escutcheons:
 - 1. Using new materials, replace broken and damaged escutcheons.

3.7 SLEEVES APPLICATION

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above and below Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 2. Concrete Slabs-on-Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs above Grade:
 - a. Sleeves with waterstops.
 - 4. Interior Walls and Partitions:

- a. Sleeves without waterstops.

3.8 ESCUTCHEONS APPLICATION

A. Escutcheons for Piping:

1. Chrome-Plated Piping: One piece, steel, cast brass, or split plate steel with polished, chrome-plated finish.
2. Bare Piping at Wall Penetrations in Finished Spaces:
 - a. One piece, steel with polished, chrome-plated or polished brass finish.
 - b. One piece, stainless steel with polished stainless steel finish.
 - c. One piece, cast brass with polished, chrome-plated or polished brass finish.
3. Bare Piping at Ceiling Penetrations in Finished Spaces:
 - a. One piece, steel with polished, chrome-plated or polished brass finish.
 - b. One piece, stainless steel with polished stainless steel finish.
 - c. One piece, cast brass with polished, chrome-plated or polished brass finish.
4. Bare Piping in Unfinished Service Spaces:
 - a. One piece, steel with polished, chrome-plated finish.
 - b. One piece, cast brass with polished, chrome-plated or rough-brass finish.
 - c. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
5. Bare Piping in Equipment Rooms:
 - a. One piece, steel with polished, chrome-plated finish.
 - b. One piece, cast brass with polished, chrome-plated or rough-brass finish.
 - c. One piece, stamped steel or split plate, stamped steel with concealed hinge polished, chrome-plated finish.

END OF SECTION

SECTION 21 05 23**GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Two-piece ball valves with indicators.
 - 2. Iron butterfly valves with indicators.
 - 3. Check valves.
 - 4. Bronze OS&Y gate valves.
 - 5. Iron OS&Y gate valves.
 - 6. NRS gate valves.
 - 7. Trim and drain valves.

1.2 DEFINITIONS

- A. NRS: Nonrising stem.
- B. OS&Y: Outside screw and yoke.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and weld ends.
 - 3. Set valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.
- D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS**2.1 SOURCE LIMITATIONS**

- A. Obtain each type of valve from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:
 - 1. Fire Main Equipment: HAMV - Main Level.
 - a. Ball Valves, System Control: HLUG - Level 3.
 - b. Butterfly Valves: HLXS - Level 3.
 - c. Check Valves: HMER - Level 3.
 - d. Gate Valves: HMRZ - Level 3.
 - 2. Sprinkler System: VDGT - Main Level.
 - a. Valves, Trim and Drain: VQGU - Level 1.
- B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:
 - 1. Automated Sprinkler Systems:
 - a. Valves.
 - 1) Gate valves.
 - 2) Check valves.
 - 3) Miscellaneous valves.
- C. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded-end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B31.9 for building services piping valves.
- D. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- E. Comply with NFPA 13.
- F. Comply with the Unified Facilities Criteria (UFC 3-600-1).
- G. Valve Minimum Pressure Ratings: 175 psig.
- H. Valve Sizes: Same as upstream piping unless otherwise indicated.
- I. Valve Actuator Types:
 - 1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.

2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.3 TWO-PIECE BALL VALVES WITH INDICATORS

A. Description:

1. UL 1091, except with ball instead of disc and FM Global approved for indicating valves (butterfly or ball type), Class Number 1112.
2. Minimum Pressure Rating: 175 psig.
3. Body Design: Two piece.
4. Body Material: Forged brass or bronze.
5. Port Size: Full or standard.
6. Seats: PTFE.
7. Stem: Bronze or stainless steel.
8. Ball: Chrome-plated brass.
9. Actuator: Worm gear
10. End Connections for Valves: Threaded ends.

2.4 IRON BUTTERFLY VALVES WITH INDICATORS

A. Description:

1. Standard: UL 1091 and FM Global standard for indicating valve.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, or polyamide coating.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron, nickel plated and EPDM or SBR coated.
7. Actuator: Worm gear.
8. Supervisory Switch: Internal, pre-wired.
9. Body Design: Grooved-end connections.
10. Basis of Design: Tyco Fire Protection Products, BFV-N or equal.

2.5 CHECK VALVES

A. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psig.
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel, with elastomeric seal.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.
10. Basis of Design: Tyco Fire Protection Products, Model CV-1F or equal.

2.6 IRON OS&Y GATE VALVES

A. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. CWP: 250 psi.
4. Handwheel: Cast Iron ASTM A126, Class B.
5. Body and Bonnet Material: Cast or ductile iron.
6. Wedge: Cast or ductile iron, or bronze, with elastomeric coating.
7. Wedge Seat: Cast or ductile iron, or bronze, with elastomeric coating.
8. Stem: Brass or bronze.
9. Packing: Non-asbestos PTFE.
10. Pre-grooved stem for supervisory switch.
11. End Connections: Flanged, Grooved, or Threaded.
12. Basis of Design: Watts 408-OSY-RW or equal.

2.7 TRIM AND DRAIN VALVES

A. Ball Valves:

1. Description:

- a. Pressure Rating: 175 psig.
- b. Body Design: Two piece.
- c. Body Material: Forged brass or bronze.
- d. Port size: Full or standard.
- e. Seats: PTFE.
- f. Stem: Bronze or stainless steel.
- g. Ball: Chrome-plated brass.
- h. Actuator: Handlever.
- i. End Connections for Valves: Threaded ends.

B. Angle Valves:

1. Description:

- a. Pressure Rating: 175 psig.
- b. Body Material: Brass or bronze.
- c. Ends: Threaded.
- d. Stem: Bronze.
- e. Disc: Bronze.
- f. Packing: Asbestos free.
- g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:

1. Description:

- a. Pressure Rating: 175 psig.

- b. Body Material: Bronze with integral seat and screw-in bonnet.
- c. Ends: Threaded.
- d. Stem: Bronze.
- e. Disc Holder and Nut: Bronze.
- f. Disc Seat: Nitrile.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

D. Automatic (Ball Drip) Drain Valves:

- 1. Standard: UL 1726.
- 2. Pressure Rating: 175-psig minimum.
- 3. Type: Automatic draining, ball check.
- 4. Size: NPS 3/4.
- 5. End Connections: Threaded.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION, GENERAL

- A. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply, except from fire-department connections. Install permanent identification signs, indicating portion of system controlled by each valve.
- B. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above the pipe center.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags.

- F. Install permanent identification signs indicating the portion of system controlled by each valve.

END OF SECTION

SECTION 21 05 29**HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal hanger-shield inserts.
 - 5. Fastener systems.
 - 6. Equipment supports.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Signed and sealed by a qualified professional. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Include design calculations for designing trapeze hangers.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for fire-suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7 and UFC 3-600-1.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 - 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from the Government.
- C. NFPA Compliance: Comply with NFPA 13.
- D. UL Compliance: Comply with UL 203.

2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot-dip galvanized.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with NFPA-approved, UL-listed, or FM-approved carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
 - 2. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 3. Channels: Continuous slotted carbon-steel channel with intumed lips.
 - 4. Channel Width: Selected for applicable load criteria.
 - 5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

7. Metallic Coating: Pregalvanized G90.
8. Paint Coating: Green epoxy, acrylic, or urethane.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
3. Channels: Continuous slotted carbon-steel channel with inturned lips.
4. Channel Width: Select for applicable load criteria.
5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Pregalvanized G90.
8. Paint Coating: Green epoxy, acrylic, or urethane.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: NFPA-approved, UL-listed, or FM-approved threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: Zinc-coated or Stainless steel.

2.6 EQUIPMENT SUPPORTS

- A. Description: NFPA-approved, UL-listed, or FM-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

2.7 MATERIALS

- A. Aluminum: ASTM B221 (ASTM B221M).
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout, suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Coordinate with firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. 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.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal strut systems.
- D. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Install in accordance with approvals and listings.
 - 2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Install in accordance with approvals and listings.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.

- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, etc. NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- J. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

3.3 INSTALLATION OF EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touchup:

1. Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those 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 a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with NFPA 13 requirements for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- F. Horizontal-Piping Hangers and Supports: Comply with NFPA 13 requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of stationary pipes.
 2. Steel Pipe Clamps (MSS Type 4): For suspension of if no insulation is required.
 3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes.
 4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes.
 5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes.
 6. U-Bolts (MSS Type 24): For support of heavy pipes.
 7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 and larger, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 and larger, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 and larger if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Extension Pipe or Riser Clamps (MSS Type 8).

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Comply with NFPA 13 requirements.
- I. Building Attachments: Comply with NFPA 13 requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. C-Clamps (MSS Type 23): For structural shapes.
 3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- J. Comply with NFPA 13 requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- K. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- L. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 21 05 48**VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
1. Restraints - rigid type.
 2. Restraints - cable type.
 3. Restraint accessories.
 4. Post-installed concrete anchors.
 5. Concrete inserts.

1.2 DEFINITIONS

- A. Designated Seismic System: A fire-suppression component that requires design in accordance with ASCE/SEI 7, Ch. 13 and for which the Component Importance Factor is greater than 1.0.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component.
 3. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by an agency acceptable to authorities having jurisdiction.
 4. Annotate to indicate application of each product submitted and compliance with requirements.
- B. Delegated Design Submittal:
1. For each seismic-restraint device, including seismic-restrained mounting, pipe-riser resilient support, seismic restraint, seismic-restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:
 - a. Seismic-Restraint Selection: Select seismic restraints complying with performance requirements, design criteria, and analysis data.
 - b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
 - c. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for seismic reinforcement use.

- d. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
 - e. Qualified Professional Engineer: All designated-design submittals for seismic calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
2. Seismic-Restraint Detail Drawing:
- a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to 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. Product Listing, Preapproval, and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
4. All delegated design submittals for seismic-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
- C. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for fire-suppression piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For professional engineer and testing agency.
- C. Welding certificates.
- D. Field quality-control reports.
- E. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-16, Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.
 - 1. Provide equipment manufacturer's written certification for each designated active fire-suppression system seismic device and system, stating that it will remain operable following the design earthquake. Certification shall be based on requirements of ASCE/SEI 7 and AHRI 1270 (AHRI 1271), including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction or ASCE/SEI 7-16.
 - 2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-16.

3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: an evaluation service member of ICC-ES, or an agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer to design seismic control system.
 1. Seismic Performance: Equipment shall be designed and secured to withstand the effects of earthquake motions determined in accordance with NFPA 13 and ASCE/SEI 7-16.
 2. Comply with the Unified Facilities Criteria (UFC 3-600-1).
- B. Seismic Design Calculations:
 1. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in NFPA 13 and ASCE/SEI 7-16. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the Section Text.
 - a. Data indicated below to be determined by Delegated Design Contractor shall be obtained by Contractor and shall be included in individual component submittal packages.
- C. Consequential Damage: Provide additional seismic for suspended fire-suppression system components or anchorage of floor-, roof-, or wall-mounted fire-suppression system components as indicated in ASCE/SEI 7-16 so that failure of a non-essential or essential fire-suppression system component will not cause the failure of any other essential architectural, mechanical, or electrical building component.

- D. Fire/Smoke Resistance: Seismic-restraint devices that are not constructed of ferrous metals shall have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723 and be so labeled.
- E. Component Supports:
 - 1. Load ratings, features, and applications of all reinforcement components shall be based on testing standards of a nationally recognized testing agency.
 - 2. All component support attachments shall comply with force and displacement resistance requirements of ASCE/SEI 7-16 Section 13.6.

2.2 RESTRAINTS - RIGID TYPE

- A. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes 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; rated in tension, compression, and torsion forces.

2.3 RESTRAINTS - CABLE TYPE

- A. Seismic-Restraint Cables: ASTM A1023/A12023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.
- B. Restraint cable assembly with cable fittings shall comply with ASCE/SEI 19. All cable fittings and complete cable assembly shall maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.4 RESTRAINT ACCESSORIES

- A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.
- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid restraints and restraint cables.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
- D. 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 used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.5 POST-INSTALLED CONCRETE ANCHORS

- A. Mechanical Anchor Bolts:
 - 1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.
- B. Adhesive Anchor Bolts:
 - 1. Drilled-in and capsule anchor system containing PVC 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 E488/E488M.
- C. Provide post-installed concrete anchors that have been prequalified for use in seismic applications. Post-installed concrete anchors shall comply with all requirements of ASCE/SEI 7-16, Ch. 13.
 - 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
 - 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

2.6 CONCRETE INSERTS

- A. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.
- B. Comply with ANSI/MSS SP-58.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

- B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry calculated static and seismic loads within specified loading limits.

3.3 INSTALLATION OF SEISMIC-RESTRAINT DEVICES

- A. Installation of seismic restraints shall not cause any stresses, misalignment, or change of position of equipment or piping.
- B. Comply with installation requirements of NFPA 13 for installation of all seismic-restraint devices.
- C. Piping Restraints:
 - 1. Comply with all requirements in NFPA 13.
 - 2. Design piping sway bracing in accordance with NFPA 13.
 - a. Maximum spacing of all sway bracing to be no greater than indicated in NFPA 13.
 - b. Design loading of all sway bracing not to exceed values indicated in NFPA 13.
- D. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- F. 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.
- G. 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.
- H. Post-Installed Concrete Anchors:
 - 1. 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.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors to be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive-Type Anchor Bolts: 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.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross structural seismic joints and other points where differential movement may occur, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain owner's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at no fewer than four of each type and size of installed anchors and fasteners selected by Owner.
 - 5. Test to 90 percent of rated proof load of device.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Units will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION

SECTION 21 05 53**IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Stencils.
 - 4. Valve tags.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.
- D. Valve-numbering scheme.
- E. Valve Schedules: Provide for fire-suppression piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS**2.1 EQUIPMENT LABELS**

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 0.032 inch thick, with predrilled or stamped holes for attachment hardware.
 - 2. Letter and Background Color: As indicated for specific application under Part 3.
 - 3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 4. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 5. Fasteners: Stainless steel rivets or self-tapping screws.
 - 6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
2. Letter and Background Color: As indicated for specific application under Part 3.
3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.**2.2 PIPE LABELS**

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include the following:
 1. Pipe size.
 2. Flow-Direction Arrows: Include flow-direction arrows on system riser and main piping. Arrows may be either integral with label or applied separately.
 3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

2.3 STENCILS**A. Stencils for Piping:**

1. Lettering Size: Size letters in accordance with ASME A13.1 for piping.
2. Stencil Material: Aluminum, brass, or fiberboard.
3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, alkyd enamel. Paint may be in pressurized spray-can form.
5. Letter and Background Color: As indicated for specific application under Part 3.

2.4 VALVE TAGS

- A. Description: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.04 inch thick, with predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire, link chain, beaded chain, or S-hook.
- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open or closed), and variations for identification.
 - 1. Include valve-tag schedule in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION GENERAL REQUIREMENTS

- A. All identification shall comply with NFPA 13 and the Government.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS

- A. Permanently fasten labels on each item of fire-suppression equipment.
- B. Sign and Label Colors:
 - 1. White letters on an ANSI Z535.1 safety-red background.
- C. Locate equipment labels where accessible and visible.

3.4 INSTALLATION OF PIPE LABELS

- A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

- B. Stenciled Pipe-Label Option: Stenciled labels showing service and flow direction may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- C. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces as follows:
 - 1. Within 3 ft. of each valve and control device.
 - 2. At access points that permit a view of concealed piping.
 - 3. Within 3 ft. of equipment items and other points of origination and termination.
 - 4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.
- D. Flow-Direction Arrows: Provide arrows to indicate direction of flow in pipes.
- E. Fire-Suppression Pipe Label Color Schedule:
 - 1. Fire-Suppression Pipe Labels: White letters on an ANSI Z535.1 safety-red background.

3.5 INSTALLATION OF VALVE TAGS

- A. Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule in the operating and maintenance manual. Include the identification "FSV" on all fire-suppression system valve tags.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.
 - 1. Valve-Tag Size and Shape: Wet-Pipe Sprinkler System: 2 inches, square.
 - 2. Valve-Tag Color: White letters on an ANSI Z535.1 safety-red background.

END OF SECTION

SECTION 21 08 00**COMMISSIONING OF FIRE SUPPRESSION****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section includes Cx process requirements for the following fire-suppression systems, assemblies, and equipment:
 - 1. Water-based fire-suppression systems.

1.2 DEFINITIONS

- A. Cx: Commissioning.
- B. CxA: Commissioning Authority.
- C. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fire-suppression testing technician.
- B. Construction Checklists:
 - 1. Draft Cx plan, including draft construction checklists to be prepared by CxA.
 - 2. Cx plan, including material, installation, and performance construction checklists for systems, assemblies, subsystems, equipment, and components relating to fire-suppression system to be part of the Cx process.
- C. Test Equipment and Instruments: For all test equipment and instruments to be used in conducting Cx tests by Contractor, provide the following:
 - 1. Equipment/instrument identification number.
 - 2. Planned Cx application or use.
 - 3. Manufacturer, make, model, and serial number.
 - 4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
 - 5. Equipment manufacturers' proprietary instrumentation and tools. For each instrument or tool, identify the following:
 - a. Instrument or tool identification number.
 - b. Equipment schedule designation of equipment for which the instrument or tool is required.
 - c. Manufacturer, make, model, and serial number.

- d. Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

1.4 QUALITY ASSURANCE

- A. Fire-Suppression Testing Technician Qualifications: Technicians to perform fire-suppression Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:
 1. Journey level or equivalent skill level with knowledge of fire-suppression system, electrical concepts, and building operations.
 2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
- B. Testing Equipment and Instrumentation Quality and Calibration:
 1. Capable of testing and measuring performance within the specified acceptance criteria.
 2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
 3. Be maintained in good repair and operating condition throughout duration of use on Project.
 4. Be recalibrated/repared if dropped or damaged in any way since last calibrated.
- C. Proprietary Test Instrumentation and Tools:
 1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:
 - a. Be calibrated by manufacturer with current calibration tags permanently affixed.
 - b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
 - c. Fire-suppression system proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 Cx PROCESS

- A. Perform Cx process for fire-suppression system.

3.2 CONSTRUCTION CHECKLISTS

- A. Systems Required to Be Commissioned:
 1. Fire-suppression sprinkler systems, including the following:

- a. Wet-pipe sprinkler piping, fittings, sprinklers, and specialties.
- b. Sleeves and sleeve seals.
- c. Gauges.
- d. General-duty valves.
- e. Hangers and supports.
- f. Vibration isolation and seismic restraints.
- g. Identification.
- h. Fire department connection.
- i. Backflow preventer and forward flow test.

2. Documentation:

- a. Fire-suppression system operating manuals.
- b. Documentation of required Cx.
- c. Documentation of required operator training.

3.3 Cx TESTING PREPARATION

- A. Certify that fire-suppression systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.
- B. Certify that fire-suppression system instrumentation and control systems have been completed and calibrated, that they are operating in accordance with the Contract Documents and approved submittals, and that pretest set points have been recorded.
- C. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (for example: and alarm conditions).

3.4 Cx TESTS COMMON TO FIRE-SUPPRESSION SYSTEMS

- A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.
- B. Test systems, assemblies, subsystems, equipment, and components for operating modes, compared to acceptance criteria.
- C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.
- D. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance test requirements specified in Division 21 Sections specifying fire-suppression systems and equipment.
- E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:
 - 1. Cx Construction Checklist verification tests.
 - 2. Cx Construction Checklist verification test demonstrations.

3.5 CONSTRUCTION CHECKLIST EXAMPLES

A. Vibration Isolation in Fire-Suppression Systems:

1. Prerequisites: Acceptance of results of construction checklists for vibration and seismic control devices.
2. Components to Be Tested:
 - a. Vibration isolation control devices in water-based fire-suppression systems.
 - b. Seismic control devices for proper installation.
 - c. Support systems.
3. Test Purpose: Evaluate effectiveness of vibration isolation and proper installation of seismic control devices.
4. Acceptance Criteria: Structure-borne vibration not to exceed specified performance.

B. Supervision of Fire-Protection Valves in Water-Based Fire-Suppression Systems:

1. Equipment and Systems to Be Tested:
 - a. Supervised valves in water-based fire-suppression systems.
2. Test Purpose: Verify generation of supervisory alarm at the fire-alarm control panel in response to activation of valve supervision device or tamper switch.
3. Test Conditions:
 - a. Fire-alarm system operating in normal, automatic mode.
 - b. Activate valve supervision devices and tamper switches, one at a time.
4. Acceptance Criteria: Activation of valve supervision device or tamper switch generates supervisory alarm at fire-alarm control panel.

END OF SECTION

SECTION 21 11 19**FIRE DEPARTMENT CONNECTION****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Flush-type fire-department connection.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire-department connection.

PART 2 - PRODUCTS**2.1 FLUSH-TYPE FIRE-DEPARTMENT CONNECTION**

- A. Standard: UL 405.
- B. Type: Flush, for wall mounting.
- C. Pressure Rating: 175 psig minimum.
- D. Body Material: Corrosion-resistant metal.
- E. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
- F. Caps: Brass, lugged type, with gasket and chain.
- G. Escutcheon Plate: Rectangular, brass, wall type.
- H. Outlet: With pipe threads.
- I. Number of Inlets: NPS 2-1/2 each.
- J. Outlet Location: Back.
- K. Outlet Location: NPS 6.
- L. Escutcheon Plate Marking: "AUTO SPKR" per NFPA 13.

- M. Finish: Polished chrome plated or Rough brass or bronze.
- N. Installation Height: In accordance with NFPA 13.
- O. Comply with the Unified Facilities Criteria (UFC 3-600-1).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connection.
- B. Examine roughing-in for fire-suppression piping to verify actual locations of piping connections before fire-department connection installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-type fire-department connection in accordance with NFPA 13.
- B. Install automatic (ball-drip) drain valve at check valve for fire-department connection.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections: Verify that hose threads coordinate with the local fire-department equipment.

END OF SECTION

SECTION 21 13 13**WET-PIPE SPRINKLER SYSTEMS****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Steel pipe and fittings.
 - 2. Air vent.
 - 3. Sprinkler piping specialties.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Pressure gauges.
 - 7. Backflow preventer.
 - 8. Alarm check valve.

1.2 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings and Working Plans: For wet-pipe sprinkler systems.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.
- C. Delegated Design Submittals: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data, signed and sealed by the qualified professional NICET Level III-certified technician.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and professional NICET certified technician.
- B. Design Data: Approved sprinkler piping working plans, prepared according to NFPA 13.
- C. Welding certificates.
- D. Field Test Reports:

1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional services needed to assume design responsibility. Base calculations on results of fire-hydrant flow test.

- a. Designer Responsibility: Preparation of working plans, calculations, and field test reports by NICET Level III-certified technician,

- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. 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.
- B. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with NFPA 13 and with the Unified Facilities Criteria (UFC 3-600-1).
- C. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- D. Review fire hydrant flow test reports.
- E. Delegated Design: Engage a qualified professional to design wet-pipe sprinkler systems.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through fire water-service piping, backflow preventer, valves, sprinkler system risers, sprinkler piping, and sprinklers.
 2. Sprinkler Occupancy Hazard Classification:
 - a. Comply with NFPA 13 and with the Unified Facilities Criteria (UFC 3-600-1).
 - b. Offices, Administration Areas, and Classrooms: Light
 - c. Mechanical, Electrical, Janitorial, and Maintenance: Ordinary.
 - d. Simulator: Ordinary.
 3. Minimum Density for Automatic-Sprinkler Wet Piping Design:
 - a. Comply with NFPA 13 and with the Unified Facilities Criteria (UFC 3-600-1).
 - b. Light-Hazard Occupancy: 0.10 GPM/sq. ft. over 1,500 sq. ft. remote area.
 - c. Ordinary-Hazard Occupancy: 0.20 GPM/sq. ft. over 2,500 sq. ft. remote area.
 4. Maximum Spacing per Sprinkler:
 - a. Comply with NFPA 13 and with the Unified Facilities Criteria (UFC 3-600-1).
 - b. Light-Hazard Occupancy: 15 ft.
 - c. Ordinary-Hazard Occupancy: 15 sq. ft.
 5. Maximum Protection Area per Sprinkler:
 - a. Comply with NFPA 13 and with the Unified Facilities Criteria (UFC 3-600-1).
 - b. Light-Hazard Occupancy: 225 sq. ft.
 - c. Ordinary-Hazard Occupancy: 130 sq. ft.
 6. Sprinkler K-Factor:
 - a. Comply with NFPA 13 and with the Unified Facilities Criteria (UFC 3-600-1).
 - b. Light-Hazard Occupancy: K-5.6
 - c. Ordinary-Hazard Occupancy: K-8.0
 7. Total Combined Hose Stream Demand:
 - a. Comply with NFPA 13 and with the Unified Facilities Criteria (UFC 3-600-1).
 - b. Light-Hazard Occupancy: 250 GPM
 - c. Ordinary-Hazard Occupancy: 250 GPM
- F. Obtain documented approval of sprinkler system design from the Government.
- G. Seismic Performance: Sprinkler piping to withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7 and UFC 3-600-1.

2.2 STEEL PIPE AND FITTINGS

- A. All piping shall be minimum Schedule 40 thickness.

- B. Schedule 40 Steel Pipe: Black-steel pipe, ASTM A53/A53M, Type E, Grade B.
- C. Schedule 40 Steel Pipe: Black-steel pipe, ASTM A135/A135M; ASTM A795/A795M, Type E.
- D. Steel Pipe Nipples: Black steel, ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.
- E. Steel Couplings: Uncoated steel, ASTM A865/A865M, threaded.
- F. Gray-Iron Threaded Fittings: Uncoated gray-iron threaded fittings, ASME B16.4, Class 125, standard pattern.
- G. Malleable- or Ductile-Iron Unions: UL 860.
- H. Cast-Iron Flanges: ASME 16.1, Class 125.
- I. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
 - 1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or EPDM rubber gasket.
 - a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
 - b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
 - 2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.
- J. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.
 - 1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- K. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Pressure Rating: 175-psig minimum.
 - 2. Grooved-End Fittings for Steel Piping: Uncoated grooved-end fittings, ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
 - 3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 AIR VENT

- A. Automatic Air Vent:
 - 1. Description: Automatic air vent that automatically vents trapped air without human intervention.
 - 2. Standard: UL listed or FM Global approved for use in wet-pipe fire sprinkler systems.
 - 3. Vents oxygen continuously from system.
 - 4. Float valve to prevent water discharge.
 - 5. Minimum Water Working Pressure Rating: 175 psig.

B. Automatic Air Vent Assembly:

1. Description: Automatic air vent assembly that automatically vents trapped air without human intervention, including Y-strainer and ball valve in a pre-piped assembly.
2. Standard: UL listed or FM Global approved for use in wet-pipe fire sprinkler system.
3. Vents oxygen continuously from system.
4. Float valve to prevent water discharge.
5. Minimum Water Working Pressure Rating: 175 psig.

2.4 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175-psig.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-tee and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved or threaded.

B. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: 175-psig minimum.
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:

1. Standard: UL 199.
2. Pressure Rating: 175 psig.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: 175-psig minimum.
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

1. Standard: UL 1474.
2. Pressure Rating: 250-psig minimum.
3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

2.5 SPRINKLERS

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- C. Automatic Sprinklers with Heat-Responsive Element:
1. Applications: UL 199.
- D. Sprinkler Finishes: Chrome plated.
- E. Sprinklers for Server Rooms shall be standard response, intermediate temperature classification.
- F. Special Coatings: Wax lead and corrosion-resistant paint.
- G. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
- H. Sprinkler Guards:
1. Standard: UL 199.
 2. Type: Wire cage with fastening device for attaching to sprinkler.

2.6 ALARM DEVICES

- A. Alarm-device types to match piping and equipment connections.
- B. Water-Motor-Operated Alarm:
1. Basis of Design: Viking or equal.
 2. Standard: UL 753.
 3. Type: Mechanically operated, with Pelton wheel.
 4. Alarm Gong: Cast aluminum with red-enamel factory finish.
 5. Size: 8-1/2-inches diameter.
 6. Components: Shaft length, bearings, and sleeve to suit wall construction.

7. Inlet: NPS 3/4.
8. Outlet: NPS 1 drain connection.

C. Waterflow Switch:

1. Basis of Design: Potter VSR Series or equal.
2. U.L. Listed and FM Approved.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

D. Valve Supervisory Switches:

1. Basis of Design: Potter OSYSU Series or equal.
2. U.L. Listed and FM Approved.
3. Type: Electrically supervised, with visual switch indicator and adjustable length trip rod.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.
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.

2.7 PRESSURE GAUGES

- A. Standard: UL 393.
- B. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- C. Pressure Gauge Range: 0- to 250-psig minimum.
- D. Label: Include "WATER" label on dial face.

2.8 DOUBLE-CHECK DETECTOR BACKFLOW PREVENTION ASSEMBLY

1. Basis of Design: Zurn Model 350ADA or equal.
2. U.L. Listed, FM Approved, and ASSE 1048 Approved.
3. Pressure Rating: 175-psig maximum.
4. Orientation: Horizontal.
5. Body Material: Ductile iron.
6. End Connections: Flanged.
7. Valve Operation: Outside stem and yoke resilient seated gate valves, with integral supervisory switches.
8. Continuous operation design.

9. The auxiliary bypass line shall consist of an approved double check assembly and water meter.

2.9 ALARM CHECK VALVE

1. Basis of Design: Tyco Fire Protection Products, Model AV-1-300 or equal.
2. U.L. Listed and FM Approved.
3. Pressure Rating: 175-psig minimum.
4. Body Material: Ductile iron.
5. Seat Ring: Bronze.
6. Clapper: Stainless Steel.
7. End Connections: Flanged.
8. Trim shall include pressure gauges, retard chamber, main drain valve, and electrical sprinkler pressure alarm switch.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING

- A. Locations and Arrangements: Drawing plans and schematics indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 1. Deviations from approved working plans for piping require written approval from the Government. File written approval before deviating from approved working plans.
 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Install seismic restraints on piping. Comply with NFPA 13 and UFC 3-600-1 requirements for seismic-restraint device materials and installation.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- F. Install couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drains.
- J. Drain valves shall be fully accessible and located no higher than 7'-0" AFF.

- K. Install automatic (ball drip) drain valve at check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill to outside building.
- L. Install alarm devices in piping systems.
- M. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- N. Install pressure gauges on sprinkler system zone control. Include pressure gauges with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not subject to freezing.
- O. Fill sprinkler system piping with water.
- P. Install sleeves for piping penetrations of walls and ceilings.
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs.
- R. Install escutcheons for piping penetrations of walls and ceilings.

3.2 JOINT CONSTRUCTION

- A. Install fittings that have finish and pressure ratings same as or higher than system's pressure rating.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. 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:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- G. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated.
- H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

- I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 INSTALLATION OF VALVES AND SPECIALTIES

- A. Install listed fire-protection valves, trim and drain valves, controls, and specialties according to NFPA 13.
- B. Install listed fire-protection shutoff and control valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install fire department check valve.
- D. Install backflow preventer.
- E. Air Vent:
 - 1. Provide at least one air vent at high point in each wet-pipe sprinkler system in accordance with NFPA 13 requirements. Connect vent into top of fire sprinkler piping.
 - 2. Provide dielectric union for dissimilar metals, ball valve, and strainer upstream of automatic air vent.
 - 3. Pipe from outlet of air vent to drain.

3.4 INSTALLATION OF SPRINKLERS

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels or quarter-center of acoustical ceiling panels.
- B. Install sprinklers and space in accordance with NFPA 13 and with the Unified Facilities Criteria (UFC 3-600-1).

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.7 PIPING SCHEDULE

- A. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- B. Standard-Pressure, Aboveground, Wet-Pipe Sprinkler System, NPS 2 and Smaller, to be the Following:
 - 1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
- C. Standard-Pressure, Aboveground, Wet-Pipe Sprinkler System and Fire Department Connection Piping, NPS 2-1/2 and Larger, to be the Following:
 - 1. Schedule 40, black-steel pipe with grooved ends; uncoated, grooved end fittings; and grooved joints.

3.8 SPRINKLER SCHEDULE

- A. Coordinate with the Government.
 - 1. Rooms without Ceilings: Upright, brass sprinklers.
 - 2. Rooms with Ceilings: Concealed sprinklers.

END OF SECTION

SECTION 22 05 17
SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Pipe sleeves.
- B. Pipe sleeve-seals.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 22 05 23 - General-Duty Valves for Plumbing Piping.
- C. Section 22 07 19 - Plumbing Piping Insulation.

1.03 REFERENCE STANDARDS

- A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.
- C. FM (AG) - FM Approval Guide.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
- C. Maintenance Materials: Furnish the following for Government's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Valve Stem Packings: Two for each type and size of valve.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified this section.
 - 1. Minimum three years experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.
- B. Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

1.07 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS**2.01 PIPE SLEEVES**

- A. Manufacturers:
- B. Vertical Piping:
 - 1. Sleeve Length: 1 inch above finished floor.
 - 2. Provide sealant for watertight joint.
 - 3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
 - 4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.

- C. Plastic or Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
- D. Pipe Passing Through Below Grade Exterior Walls:
 - 1. Zinc coated or cast iron pipe.
 - 2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
- E. Clearances:
 - 1. Provide allowance for insulated piping.
 - 2. Wall, Floor, Partitions, and Beam Flanges: 1 inch greater than external pipe diameter.
 - 3. All Rated Openings: Caulked tight with fire stopping material complying with ASTM E814 in accordance with Section 07 84 00 to prevent the spread of fire, smoke, and gases.

2.02 PIPE-SLEEVE SEALS

- A. Manufacturers:
 - 1. Advance Products & Systems, LLC; Innerlynx: www.apsonline.com/#sle.
 - 2. Flexicraft Industries; PipeSeal: www.flexicraft.com/#sle.
- B. Modular Mechanical Sleeve-Seal:
 - 1. Elastomer-based interlocking links continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
 - 2. Watertight seal between pipe and wall-sleeve, wall or casing opening.
 - 3. Size and select seal component materials in accordance with service requirements.
 - 4. Service Requirements:
 - a. Underground, buried, and wet conditions.
 - 5. Glass-reinforced plastic pressure end plates.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.

3.02 INSTALLATION

- A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- B. Install piping to conserve building space, to not interfere with use of space and other work.
- C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- D. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- E. Structural Considerations: Do not penetrate building structural members unless indicated.
- F. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
 - 1. Aboveground Piping:
 - a. Pack solid using mineral fiber complying with ASTM C592.
 - b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
 - 2. All Rated Openings: Caulk tight with fire stopping material complying with ASTM E814 in accordance with Section 07 84 00 to prevent the spread of fire, smoke, and gases.
- G. Manufactured Sleeve-Seal Systems:
 - 1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.

2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
 3. Locate piping in center of sleeve or penetration.
 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 5. Tighten bolting for a water-tight seal.
 6. Install in accordance with manufacturer's recommendations.
- H. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.03 CLEANING

- A. Upon completion of work, clean all parts of the installation.
- B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION

SECTION 22 05 19
METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Pressure gauges and pressure gauge taps.
- B. Thermometers and thermometer wells.

1.02 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments.
- B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
- C. Project Record Documents: Record actual locations of components and instrumentation.
- D. Maintenance Materials: Furnish the following for Government's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements. for additional provisions.

PART 2 PRODUCTS**2.01 PRESSURE GAUGES**

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc.
 - 2. Moeller Instrument Company, Inc.
 - 3. Omega Engineering, Inc.
 - 4. _____.
 - 5. Substitutions: Or Approved Equal.
- B. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - 1. Case: Steel with brass bourdon tube.
 - 2. Size: 4-1/2 inch diameter.
 - 3. Mid-Scale Accuracy: One percent.
 - 4. Scale: Psi and kPa.

2.02 PRESSURE GAUGE TAPPINGS

- A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.
- B. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.
- C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.
- D. Syphon: Steel, Schedule 40, 1/4 inch angle or straight pattern.

2.03 STEM TYPE THERMOMETERS

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc.
 - 2. Omega Engineering, Inc.
 - 3. Weksler Glass Thermometer Corp.
 - 4. Substitutions: Or Approved Equal.
- B. Thermometers - Fixed Mounting: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish.
 - 1. Size: 9 inch scale.

2. Window: Clear Lexan.
 3. Stem: ____ inch brass.
 4. Accuracy: 2 percent, per ASTM E77.
 5. Calibration: Degrees F.
- C. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Extend nipples and siphons to allow clearance from insulation. Provide siphon on gauges in steam systems.
- C. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- D. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.02 SCHEDULES

- A. Pressure Gauges, Location and Scale Range:
 1. Pressure reducing valves.
 2. Backflow preventers.
 3. Water Heaters.
- B. Stem Type Thermometers, Location and Scale Range:
 1. Domestic hot water supply and recirculation, 0 to ____ degrees F.
 2. Water heaters.

END OF SECTION

SECTION 22 05 23
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Ball valves.
- B. Check valves.

1.02 RELATED REQUIREMENTS

- A. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
- B. Section 22 07 19 - Plumbing Piping Insulation.
- C. Section 22 10 05 - Plumbing Piping.

1.03 ABBREVIATIONS AND ACRONYMS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Non-rising stem.
- E. OS&Y: Outside screw and yoke.
- F. PTFE: Polytetrafluoroethylene.
- G. RS: Rising stem.
- H. TFE: Tetrafluoroethylene.
- I. WOG: Water, oil, and gas.

1.04 REFERENCE STANDARDS

- A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
- B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- C. ASME B31.9 - Building Services Piping.
- D. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.
- E. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings.
- F. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
- G. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves.
- H. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
- I. NSF 61 - Drinking Water System Components - Health Effects.
- J. NSF 372 - Drinking Water System Components - Lead Content.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Government's name and registered with manufacturer.
- D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.06 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Obtain valves for each valve type from single manufacturer.
 - 2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
 - 2. Protect valve parts exposed to piped medium against rust and corrosion.
 - 3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
 - 4. Secure check valves in either the closed position or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection and protect flanges and specialties from dirt.
 - a. Provide temporary inlet and outlet caps.
 - b. Maintain caps in place until installation.
 - 2. Store valves in shipping containers and maintain in place until installation.
 - a. Store valves indoors in dry environment.
 - b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

PART 2 PRODUCTS**2.01 APPLICATIONS**

- A. See drawings for specific valve locations.
- B. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).
- C. Provide the following valves for the applications if not indicated on drawings:
 - 1. Shutoff: Ball.
 - 2. Throttling: Ball.
 - 3. Swing Check (Pump Outlet):
 - a. 2 inch and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
- D. Substitutions of valves with higher CWP classes or WSP ratings for same valve types are permitted when specified CWP ratings or WSP classes are not available.
- E. Domestic, Hot and Cold Water Valves:
 - 1. 2 inch and Smaller:
 - a. Bronze and Brass: Provide with solder-joint ends.
 - b. Ball: Two piece, full port, brass with brass trim.
 - c. Bronze Swing Check: Class 125, bronze disc.

2.02 GENERAL REQUIREMENTS

- A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- B. Valve Sizes: Match upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
 - 1. Hand Lever: Quarter-turn valves 6 inch and smaller except plug valves.
- D. Insulated Piping Valves: With 2 inch stem extensions and the following features:
 - 1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
- E. Valve-End Connections:
 - 1. Threaded End Valves: ASME B1.20.1.

2. Solder Joint Connections: ASME B16.18.
- F. General ASME Compliance:
 1. Solder-joint Connections: ASME B16.18.
- G. Potable Water Use:
 1. Certified: Approved for use in compliance with NSF 61 and NSF 372.
 2. Lead-Free Certified: Wetted surface material includes less than 0.25 percent lead content.
- H. Source Limitations: Obtain each valve type from a single manufacturer.

2.03 BRASS, BALL VALVES

- A. Two Piece, Full Port with Brass Trim and Female Thread, Male thread, or Solder Connections:
 1. Comply with MSS SP-110.
 2. WSP Rating: 150 psi.
 3. WOG Rating: 600 psi.
 4. Body: Forged brass.
 5. Seats: PTFE.
 6. Ball: Chrome-plated brass.
 7. Operator: Stem extension
 8. Manufacturers:
 - a. Apollo Valves.
 - b. Nibco Valves.
 - c. FNW.
 - d. Substitutions: Or Approved Equal.
- B. Two Piece, Full Port with Press Connections:
 1. WSP Rating: 150 psi.
 2. Body: Forged brass.
 3. Seats: EPDM.
 4. Ball: Chrome-plated brass.
 5. Blow-out Proof Stem: Forged brass.
 6. Operator: Provide stem extension.
 7. Maximum Service Temperature: 250 degrees F.
 8. Manufacturers:
 - a. Apollo Valves.
 - b. Nibco Valves.
 - c. Substitutions: Or Approved Equal.

2.04 BRONZE, BALL VALVES

- A. General:
 1. Fabricate from dezincification resistant material.
 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. One Piece, Reduced Port with Bronze Trim:
 1. Comply with MSS SP-110.
 2. WSP Rating: 400 psi.
 3. CWP Rating: 600 psi.
 4. Body: Bronze.
 5. End Connections: Pipe press.
 6. Seats: PTFE.
- C. Two Piece, Full Port with Bronze Trim:
 1. Comply with MSS SP-110.
 2. WSP Rating: 150 psi.
 3. WOG Rating: 600 psi.
 4. Body: Forged bronze or dezincified-brass alloy.

5. Ends Connections: Pipe thread or solder.
6. Seats: PTFE.
7. Stem: Bronze, blowout proof.
8. Ball: Chrome plated brass.
9. Operator: Provide stem extension.
10. Manufacturers:
 - a. Apollo Valves.
 - b. Nibco Valves
 - c. FNW.
 - d. Substitutions: Or Approved Equal.

2.05 BRONZE, LIFT CHECK VALVES

- A. General:
 1. Fabricate from dezincification resistant material.
 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Class 125:
 1. Comply with MSS SP-80, Type 1, Metal Disc to Metal Seat and Type 2, Nonmetallic Disc to Metal Seat.
 2. CWP Rating: 200 psi.
 3. Design: Vertical flow.
 4. Body: Comply with ASTM B61 or ASTM B62, bronze.
 5. End Connections: Threaded.
 6. Disc (Type 2): NBR.

2.06 BRASS, INLINE CHECK VALVES

- A. Class 150:
 1. Maximum Service Temperature: 250 degrees F.
 2. Body: Forged brass.
 3. Disc: Forged brass.
 4. Seal: PTFE, bubble-tight.
 5. End Connections: Soldered, threaded or pressed.

2.07 BRONZE, SWING CHECK VALVES

- A. General:
 1. Fabricate from dezincification resistant material.
 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Class 125:
 1. Pressure and Temperature Rating: MSS SP-80, Type 3.
 2. Design: Y-pattern, horizontal or vertical flow.
 3. WOG Rating: 200 psi.
 4. Body: Bronze, ASTM B62.
 5. End Connections: Threaded or soldered.
 6. Disc: Bronze.
 7. Manufacturers:
 - a. Apollo Valves.
 - b. Nibco Valves.
 - c. Substitutions: Or Approved Equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.
- B. Verify valve parts to be fully operational in all positions from closed to fully open.

- C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.
- D. Should valve is determined to be defective, replace with new valve.

3.02 INSTALLATION

- A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
- C. Install check valves where necessary to maintain direction of flow as follows:
 - 1. Lift Check: Install with stem plumb and vertical.
 - 2. Swing Check: Install horizontal maintaining hinge pin level.
 - 3. Orient plate-type into horizontal or vertical position, between flanges.

END OF SECTION

SECTION 22 05 29
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Prefabricated trapeze-framed systems.
- B. Strut systems for pipe or equipment support.
- C. Beam clamps.
- D. Pipe hangers.
- E. Anchors and fasteners.

1.02 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
- F. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- G. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
- H. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- I. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- J. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- L. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- M. UL (DIR) - Online Certifications Directory.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Contracting Officer or Contracting Officer's Representative of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.
- C. Installer's Qualifications: Include evidence of compliance with specified requirements.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Installer Qualifications for Field-Welding: As specified in Section 05 50 00.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide required hardware to hang or support piping, equipment, or fixtures with related accessories as necessary to complete installation of plumbing work.
- B. Provide hardware products listed, classified, and labeled as suitable for intended purpose.
- C. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.
- D. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
- E. Materials for Metal Fabricated Supports: Comply with Section 05 50 00.
 1. Zinc-Plated Steel: Electroplated in accordance with ASTM B633 unless stated otherwise.
 2. Galvanized Steel: Hot-dip galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M unless stated otherwise.
- F. Corrosion Resistance: Use corrosion-resistant metal-based materials fully compatible with exposed piping materials and suitable for the environment where installed.

2.02 PREFABRICATED TRAPEZE-FRAMED SYSTEMS

- A. Prefabricated Trapeze-Framed Metal Strut Systems:
 1. Manufacturers:
 - a. Anvil International, LLC.
 - b. Unistrut, a brand of Atkore International, Inc.
 - c. Substitutions: Or Approved Equal.
 - d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 2. Strut Channel or Bracket Material:
 - a. Indoor Dry Locations: Use zinc-plated steel or galvanized steel.
 3. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.

4. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.

2.03 STRUT SYSTEMS FOR PIPE OR EQUIPMENT SUPPORT

- A. Strut Channels:
 1. Manufacturers:
 - a. ABB Installation Products
 - b. Unistrut, a brand of Atkore International Inc.
 - c. Substitutions: Or Approved Equal.
 - d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 2. ASTM A653/A653M galvanized steel bracket with clamps for surface mounting of piping or plumbing equipment support.
 3. Channel or Bracket Kits: Include rods, brackets, end-fixed fittings, covers, clips, and other related hardware required to complete sectional trapeze section for piping or other support.
- B. Hanger Rods:
 1. Threaded zinc-plated steel unless otherwise indicated.
 2. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Piping up to 1 inch: 1/4 inch diameter.
 - b. Piping larger than 1 inch: 3/8 inch diameter.
 - c. Trapeze Support for Multiple Pipes: 3/8 inch in length.
- C. Channel Nuts:
 1. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring as indicated on drawings.

2.04 BEAM CLAMPS

- A. Manufacturers:
 1. Unistrut, a brand of Atkore International, Inc.
 2. Substitutions: Or Approved Equal.
 3. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
- B. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
- C. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.

2.05 PIPE HANGERS

- A. Band Hangers, Adjustable:
 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation.
 - b. Substitutions: Or Approved Equal..
 - c. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 2. MSS SP-58 type 7 or 9, zinc-plated ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
- B. J-Hangers, Adjustable:
 1. MSS SP-58 type 5, zinc-plated ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
- C. Clevis Hangers, Adjustable:
 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation.
 - b. FNW.
 - c. Substitutions: Or Approved Equal.

- d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
- 2. Copper Tube: MSS SP-58 type 1, epoxy-plated copper.
- 3. Standard-Duty: MSS SP-58 type 1, zinc-colored, epoxy plated.

2.06 PIPE CLAMPS

- A. Riser Clamps:
 - 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation.
 - b. FNW.
 - c. Substitutions: Or Approved Equal.
 - d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 - 2. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
 - 3. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.
 - 4. UL (DIR) listed: Pipe sizes 1/2 to 8 inch.

2.07 ANCHORS AND FASTENERS

- A. Manufacturers - Mechanical Anchors:
 - 1. FNW.
 - 2. Hilti, Inc.
 - 3. ITW Red Head, a division of Illinois Tool Works, Inc.
 - 4. Substitutions: Or Approved Equal.
- B. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
- C. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
- D. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
- E. Preset Concrete Inserts: Continuous metal strut channel and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - 1. Channel Material: Use galvanized steel.
 - 2. Manufacturer: Same as manufacturer of metal strut channel framing system.
- F. Concrete Inserts:
 - 1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation.
 - b. HoldRite, a brand of Reliance Worldwide Corporation.
 - c. Substitutions: Or Approved Equal.
 - d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

- C. Unless specifically indicated or approved by Contracting Officer or Contracting Officer's Representative, do not provide support from suspended ceiling support system or ceiling grid.
- D. Unless specifically indicated or approved by Contracting Officer or Contracting Officer's Representative, do not provide support from roof deck.
- E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- F. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- G. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.
- H. Secure fasteners according to manufacturer's recommended torque settings.
- I. Remove temporary supports.

END OF SECTION

SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Nameplates.
- B. Tags.
- C. Pipe markers.
- D. Ceiling tacks.

1.02 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Schedules:
 - 1. Submit plumbing component identification schedule listing equipment, piping, and valves.
 - 2. Detail proposed component identification data in terms of of wording, symbols, letter size, and color coding to be applied to corresponding product.
 - 3. Valve Data Format: Include id-number, location, function, and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.
- D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- E. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS**2.01 PLUMBING COMPONENT IDENTIFICATION GUIDELINE**

- A. Nameplates:
 - 1. Water heaters and expansion tank.other heat transfer products.
 - 2. Control panels, transducers, and other related control equipment products.
- B. Tags:
 - 1. Piping: 3/4 inch diameter and smaller.
 - 2. Ceiling tacks placed on lay-in ceiling surface to reference plumbing components.
- C. Pipe Markers: 3/4 inch diameter and higher.

2.02 NAMEPLATES

- A. Manufacturers:
 - 1. Brimar Industries, Inc.
 - 2. Kolbi Pipe Marker Co.
 - 3. Seton Identification Products.
 - 4. Substitutions: Or Approved Equal.
- B. Description: Laminated piece with up to three lines of text.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch.
 - 3. Background Color: Red.
 - 4. Nameplate Height: 3/4 inch.
 - 5. Nameplate Material:
 - a. Flexible: Vinyl with adhesive backing per ASTM D709.
 - b. Metal: Brass with center-side holes for screw fastening.

2.03 TAGS

- A. Manufacturers:
 - 1. Brimar Industries, Inc.
 - 2. Craftmark Pipe Markers.
 - 3. Kolbi Pipe Marker Co.
 - 4. Seton Identification Products.
 - 5. Substitutions: Or Approved Equal.
- B. Metal: Brass, 19 gauge 1-1/2 inch in diameter with smooth edges, blank, smooth edges, and corrosion-resistant ball chain. Up to three lines of text.
- C. Valve Tag Chart: Typewritten 12-point letter size list in anodized aluminum frame.
- D. Piping: 3/4 inch diameter and smaller. Include corrosion resistant chain. Identify service, flow direction, and pressure.

2.04 PIPE MARKERS

- A. Manufacturers:
 - 1. Brady Corporation.
 - 2. Brimar Industries, Inc.
 - 3. Craftmark Pipe Markers.
 - 4. Kolbi Pipe Marker Co.
 - 5. Seton Identification Products.
 - 6. Substitutions: Or Approved Equal.
- B. Comply with ASME A13.1.
- C. Flexible Marker: Factory fabricated, semi-rigid, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid conveyed.
- D. Identification Scheme, ASME A13.1:
 - 1. Primary: External Pipe Diameter, Uninsulated or Insulated.
 - a. 3/4 to 1-1/4 inches: Use 8 inch field-length with 1/2 inch text height.
 - b. 1-1/2 to 2 inches: Use 8 inch field-length with 3/4 inch text height.
 - 2. Secondary: Color scheme per fluid service.
 - a. Water; Potable: White text on green background.
 - b. Sanitary and Vent: White text on green background.
 - 3. Tertiary: Other Details.
 - a. Directional flow arrow.
 - b. Fluid.

2.05 CEILING TACKS

- A. Manufacturers:
 - 1. Craftmark Pipe Markers.
 - 2. Substitutions: Or Approved Equal.
- B. Description: Steel with 3/4 inch diameter color coded head.
- C. Color code as follows:
 - 1. Plumbing Valves: Green.

PART 3 EXECUTION**3.01 PREPARATION**

- A. Degrease and clean surfaces to receive identification products.
- B. Prepare surfaces for stencil painting, see Section 09 91 23.

3.02 INSTALLATION

- A. Install flexible nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

- B. Install tags in clear view and align with axis of piping
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install plastic tape pipe marker around pipe in accordance with manufacturer's instructions.
- E. Apply ASME A13.1 Pipe Marking Rules:
 - 1. Place pipe marker adjacent to changes in direction.
 - 2. Place pipe marker adjacent each valve port and flange end.
 - 3. Place pipe marker at both sides of floor and wall penetrations.
 - 4. Place pipe marker every 25 to 50 feet interval of straight run.
- F. Locate ceiling tacks to locate valves dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

**SECTION 22 07 19
PLUMBING PIPING INSULATION**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Cellular glass insulation.
- B. Flexible elastomeric cellular insulation.
- C. Glass fiber insulation.
- D. Jacketing and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 22 10 05 - Plumbing Piping: Placement of hangers and hanger inserts.

1.03 REFERENCE STANDARDS

- A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- B. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- C. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
- D. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- E. ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- G. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- H. SAE AMS3779 - Tape, Adhesive, Pressure-Sensitive Thermal Radiation Resistant, Aluminum Coated Glass Cloth.
- I. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS**2.01 REGULATORY REQUIREMENTS**

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER INSULATION

- A. Manufacturers:
 - 1. CertainTeed Corporation.
 - 2. Johns Manville Corporation.
 - 3. Knauf Insulation.
 - 4. Owens Corning Corporation.
 - 5. Substitutions: Or Approved Equal.
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
 - 1. K Value: ASTM C177, 0.24 at 75 degrees F.
 - 2. Maximum Service Temperature: 850 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm.
- D. Vapor Barrier Lap Adhesive: Compatible with insulation.

2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturers:
 - 1. Aeroflex USA, Inc; AEROFLEX Self-Seal.
 - 2. Armacell LLC; AP Armaflex.
 - 3. K-Flex USA LLC; Insul-Tube.
 - 4. Substitutions: Or Approved Equal.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 220 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.04 JACKETING AND ACCESSORIES

- A. PVC Plastic Jacket:
 - 1. Manufacturers:
 - a. Johns Manville Corporation.
 - b. Substitutions: Or Approved Equal.
 - 2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil, 0.010 inch.
 - e. Connections: Brush on welding adhesive.
- B. Reinforced Tape:
 - 1. Manufacturers:
 - a. Ideal Tape Co., Inc.
 - b. Substitutions: Or Approved Equal.
 - 2. FSK tape suitable for sealing seams between insulation, insulated pipe bends, and fittings resulting in a tight, smooth surface without wrinkles.
 - 3. Comply with UL 723 or ASTM E84.
 - 4. Moisture Vapor Permeability: 0.00 perm inch, when tested in accordance with ASTM E96/E96M.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- E. Glass fiber insulated pipes conveying fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- F. Glass fiber insulated pipes conveying fluids above ambient temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- G. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 84 00.

3.03 SCHEDULES

- A. Plumbing Systems: Refer to schedule on drawings.
 - 1. Domestic Hot and Cold Water Supply:
 - a. Glass Fiber Insulation:
 - b. Cellular Glass Insulation:
 - 2. Domestic Hot Water Recirculation:
 - a. Glass Fiber Insulation:

END OF SECTION

**SECTION 22 10 05
PLUMBING PIPING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Pipe, pipe fittings, specialties, and connections for piping systems.
 - 1. Sanitary waste piping, buried within 5 feet (1500 mm) of building.
 - 2. Sanitary waste piping, above grade.
 - 3. Domestic water piping, buried within 5 feet (1500 mm) of building.
 - 4. Domestic water piping, above grade.
 - 5. Pipe flanges, unions, and couplings.
 - 6. Flanges, unions, and couplings.
 - 7. Pipe hangers and supports.
 - 8. Manufactured sleeve-seal systems.
 - 9. Valves.
 - 10. Strainers.

1.02 RELATED REQUIREMENTS

- A. Section 08 31 00 - Access Doors and Panels.
- B. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
- C. Section 22 07 19 - Plumbing Piping Insulation.
- D. Section 31 23 16 - Excavation.
- E. Section 31 23 16.13 - Trenching.
- F. Section 31 23 23 - Fill.
- G. Section 33 01 10.58 - Disinfection of Water Utility Piping Systems.

1.03 REFERENCE STANDARDS

- A. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- C. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
- D. ASME B31.9 - Building Services Piping.
- E. ASME BPVC-IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators - Welding Brazing and Fusing Qualifications.
- F. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
- G. ASTM B32 - Standard Specification for Solder Metal.
- H. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
- I. ASTM B68/B68M - Standard Specification for Seamless Copper Tube, Bright Annealed.
- J. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- K. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
- L. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
- M. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- N. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- O. ASTM D2239 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.

- P. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
- Q. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- R. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
- S. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
- T. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
- U. ASTM D2855 - Standard Practice for the Two-Step (Primer & Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
- V. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- W. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- X. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast.
- Y. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
- Z. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- AA. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- BB. NSF 61 - Drinking Water System Components - Health Effects.
- CC. NSF 372 - Drinking Water System Components - Lead Content.

1.04 SUBMITTALS

- A. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- B. Welder Certificate: Include welders certification of compliance with ASME BPVC-IX.
- C. Sustainable Design Documentation: For soldered copper joints, submit installer's certification that the specified installation method and materials were used.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.
- C. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
- D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.
- E. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS**2.01 GENERAL REQUIREMENTS**

- A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.02 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A74 service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.
- B. PVC Pipe: ASTM D2665 or ASTM D3034.
 - 1. Fittings: PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.03 SANITARY SEWER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.
- B. PVC Pipe: ASTM D2665.
 - 1. Fittings: PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.
- C. PVC Pipe: ASTM D1785 Schedule 40, or ASTM D2241 SDR 26 with not less than 150 psi pressure rating.
 - 1. Fittings: ASTM D2466, PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.04 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Ductile Iron Pipe: AWWA C151/A21.51.
 - 1. Fittings: Ductile or gray iron, standard thickness.
 - 2. Joints: AWWA C111/A21.11, styrene butadiene rubber (SBR) or vulcanized SBR gasket with 3/4 inch diameter rods.
- B. PE Pipe: ASTM D2239.
 - 1. Fittings: ASTM D2609, PE.
 - 2. Joints: Mechanical with stainless steel clamp.

2.05 DOMESTIC WATER PIPING, ABOVE GRADE

- A. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), Drawn (H).
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 2. Fittings: Cast iron, coated.
 - 3. Joints: ASTM B32, alloy Sn95 solder.
 - 4. Mechanical Press Sealed Fittings: Double-pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements.
 - a. Manufacturers:
 - 1) Anvil International.
 - 2) Apollo Valves.
 - 3) Viega LLC.
 - 4) Substitutions: Or Approved Equal.

2.06 UNIONS AND COUPLINGS

- A. Unions for Pipe Sizes 3 Inches and Under:
 - 1. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.

- B. No-Hub Couplings:
 - 1. Gasket Material: Neoprene complying with ASTM C564.
 - 2. Band Material: Stainless steel.
 - 3. Eyelet Material: Stainless steel.
 - 4. Manufacturers:
 - a. MIFAB, Inc.
 - b. Substitutions: Or Approved Equal.

2.07 PIPE HANGERS AND SUPPORTS

- A. Refer to Section 22 05 29.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
 - 3. Trapeze Hangers: Welded steel channel frames attached to structure.
 - 4. Vertical Pipe Support: Steel riser clamp.

2.08 MANUFACTURED SLEEVE-SEAL SYSTEMS

- A. Manufacturers:
 - 1. The Metraflex Company.
 - 2. Substitutions: Or Approved Equal..
- B. Modular/Mechanical Seal:
 - 1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
 - 2. Provide watertight seal between pipe and wall/casing opening.
 - 3. Elastomer element size and material in accordance with manufacturer's recommendations.
 - 4. Glass reinforced plastic pressure end plates.

2.09 PIPING SPECIALTIES

- A. Refer to Section 22 10 06.

2.10 STRAINERS

- A. Manufacturers:
 - 1. Armstrong International, Inc.
 - 2. Apollo Valves
- B. Size 2 Inches and Under:
 - 1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
 - 2. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- G. Provide access where valves and fittings are not exposed.
 - 1. Coordinate size and location of access doors with Section 08 31 00.
- H. Establish elevations of buried piping outside the building to ensure piping is installed below the local frost line.
- I. Install vent piping penetrating roofed areas to maintain integrity of roof assembly; refer to Section ____.
- J. Provide support for utility meters in accordance with requirements of utility companies.
- K. Excavate in accordance with Section 31 23 16.13
- L. Backfill in accordance with Section 31 23 23.
- M. Install bell and spigot pipe with bell end upstream.
- N. Install valves with stems upright or horizontal, not inverted. Refer to Section 22 05 23.
- O. Install water piping to ASME B31.9.
- P. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.
- Q. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

3.04 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- C. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- D. Provide spring-loaded check valves on discharge of water pumps.
- E. Provide flow controls in water recirculating systems where indicated.

3.05 TOLERANCES

- A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.
- B. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Disinfect water distribution system in accordance with Section 33 01 10.58.

3.07 SERVICE CONNECTIONS

- A. Provide new sanitary sewer services. Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.
- B. Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves.

END OF SECTION

**SECTION 22 10 06
PLUMBING PIPING SPECIALTIES**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Floor Drains.
- B. Floor Sinks
- C. Hub Drains
- D. Cleanouts.
- E. Hydrants.
- F. Backflow preventers.
- G. Water hammer arrestors.
- H. Thermostatic mixing valves.

1.02 RELATED REQUIREMENTS

- A. Section 22 10 05 - Plumbing Piping.
- B. Section 22 30 00 - Plumbing Equipment.
- C. Section 22 40 00 - Plumbing Fixtures.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design.
- B. ASME A112.6.3 - Floor Drains.
- C. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies.
- D. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance.
- E. NSF 61 - Drinking Water System Components - Health Effects.
- F. NSF 372 - Drinking Water System Components - Lead Content.
- G. PDI-WH 201 - Water Hammer Arresters.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- C. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.
- D. Sustainable Design Documentation: Submit appropriate evidence that materials used in potable water systems comply with the specified requirements.
- E. Manufacturer's Qualification Statement.
- F. Operation Data: Indicate frequency of treatment required for interceptors.
- G. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- H. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, and water hammer arrestors.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

PART 2 PRODUCTS**2.01 GENERAL REQUIREMENTS**

- A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

2.02 DRAINS

- A. Floor Drains, Floor Sinks, and Hub Drains:
 - 1. Manufacturers:
 - a. Zurn Industries, LLC
 - b. Jay R. Smith Manufacturing Company.
 - c. Josam Company.
 - d. Substitutions: Or Approved Equal.
- B. General Floor Drain Construction:
 - 1. Drain outlets suited to the joint style of piping to which they are connected; provide side outlet drains where required. Provide flashing clamp device on drains installed in floor areas having waterproof membrane. Double drainage flange and weep-holes
- C. Floor Drain (FD-1):
 - 1. ASME A112.6.3; 3-inch outlet diameter, lacquered cast iron body with bottom outlet, combination invertible membrane clamp and adjustable collar with seepage pan, medium duty, stainless steel strainer and sediment bucket.
- D. Floor Drain (FD-2):
 - 1. ASME A112.21.1; Outlet size 3-inch; coated cast iron, bottom outlet, body with 12-1/4"-inch diameter, heavy duty, cast iron slotted grate, seepage pan, combination membrane flashing clamp with seepage slots, adjustable extension frame, and sediment bucket.
- E. Floor Sink (FS-1):
 - 1. ASME A112.21.1; Outlet size 4-inch; 16"x 16" x 7" deep cast iron body with slotted, 3/4 heavy-duty grate, epoxy-coated inside and top, anchor flange with seepage holes and clamp collar, combination membrane flashing clamp and frame, sediment bucket and aluminum dome strainer.
- F. Hub Drain HD-1:
 - 1. Type 304 stainless steel body, 2" no-hub outlet.

2.03 CLEANOUTS

- A. Manufacturers:
 - 1. Zurn Industries, LLC
 - 2. Jay R. Smith Manufacturing Company.
 - 3. Josam Company.
 - 4. Substitutions: Or Approved Equal.
- B. Cleanouts at Interior Finished Floor Areas:
 - 1. Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.
- C. Cleanouts at Interior Finished Wall Areas:
 - 1. Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.
- D. Cleanouts at Interior Unfinished Accessible Areas: Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.04 HYDRANTS

- A. Manufacturers:
 - 1. Zurn Industries, LLC.
 - 2. Jay R. Smith Manufacturing Company.

3. Josam Company.
 4. Substitutions: Or Approved Equal.
- B. Wall Hydrants:
1. ASSE 1019; freeze resistant, self-draining type with chrome plated wall plate hose thread spout, lockshield and removable key, and integral vacuum breaker.

2.05 BACKFLOW PREVENTERS

- A. Manufacturers:
1. Zurn Industries, LLC.
 2. Apollo Valves.
 3. Watts Regulator Company, a part of Watts Water Technologies.
 4. Substitutions: Or Approved Equal.
- B. Reduced Pressure Backflow Preventers:
1. ASSE 1013; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

2.06 WATER HAMMER ARRESTORS

- A. Manufacturers:
1. Sioux Chief.
 2. Watts Regulator Company, a part of Watts Water Technologies.
 3. Zurn Industries, LLC.
 4. Substitutions: Or Approved Equal.
- B. Water Hammer Arrestors:
1. Stainless steel construction, bellows type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range minus 100 to 300 degrees F and maximum 250 psi working pressure.

2.07 THERMOSTATIC MIXING VALVES

- A. Thermostatic Mixing Valves:
1. Manufacturers:
 - a. Leonard Valve Company.
 - b. Zurn Industries, LLC.
 - c. Substitutions: Or Approved Equal.
 2. Valve: Chrome plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment.
 3. Accessories:
 - a. Check valve on inlets.
 - b. Volume control shut-off valve on outlet.
 - c. Stem thermometer on outlet.
 - d. Strainer stop checks on inlets.

2.08 AIR VENTS

- A. Manufacturers:
1. Cash Acme, a brand of Reliance Worldwide Corporation.
 2. ITT Bell & Gossett.
 3. Taco, Inc.
 4. Substitutions: Or Approved Equal.
- B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

2.09 FLOOR DRAIN TRAP SEALS

- A. Manufacturers:
 - 1. Green Drains.
 - 2. MIFAB, Inc.
 - 3. SURE SEAL
 - 4. Substitutions: Or Approved Equal.
- B. Description: Push-fit EPDM or silicone fitting with a one-way membrane.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install floor cleanouts at elevation to accommodate finished floor.
- C. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur.
- D. Pipe relief from backflow preventer to nearest drain.
- E. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to quick closing devices.

END OF SECTION

**SECTION 22 30 00
PLUMBING EQUIPMENT**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Water Heaters:
 - 1. Commercial electric.
- B. Diaphragm-type compression tanks.
- C. In-line circulator pumps.
- D. Submersible sump pumps.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels.
- B. NEMA MG 00001 - Motors and Generators.
- C. UL 174 - Standard for Household Electric Storage Tank Water Heaters.
- D. UL 778 - Standard for Motor-Operated Water Pumps.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.
- B. Product Data:
 - 1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
 - 2. Indicate pump type, capacity, power requirements.
 - 3. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
 - 4. Provide electrical characteristics and connection requirements.
- C. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- D. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Government's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Certifications:
 - 1. Gas Water Heaters: Certified by CSA International to ANSI Z21.10.1, as applicable, in addition to requirements specified elsewhere.
 - 2. Electric Water Heaters: UL listed and labeled to UL 174.
 - 3. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
- C. Identification: Provide pumps with manufacturer's name, model number, and rating/capacity identified by permanently attached label.
- D. Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.07 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for domestic water heaters.

PART 2 PRODUCTS**2.01 WATER HEATERS**

- A. Manufacturers:
 - 1. A.O. Smith Water Products Co.
 - 2. Bock Water Heaters, Inc.
 - 3. Rheem Manufacturing Company.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Commercial Electric:
 - 1. Type: Factory-assembled and wired, electric, vertical storage.
 - 2. Performance: Refer to the drawing schedule.
 - a. Maximum Working Pressure: 150 psig.
 - 3. Electrical Characteristics: Refer to the drawing schedule.
 - 4. Tank: Glass lined welded steel; 4 inch diameter inspection port, thermally insulated with minimum 2 inches glass fiber encased in corrosion-resistant steel jacket; baked-on enamel finish.
 - 5. Controls: Automatic immersion water thermostat; externally adjustable temperature range from 60 to 180 degrees F, flanged or screw-in nichrome elements, high temperature limit thermostat.
 - 6. Accessories:
 - a. Water Connections: Brass.
 - b. Dip Tube: Brass.
 - c. Drain valve.
 - d. Anode: Magnesium.
 - e. Temperature and Pressure Relief Valve: ASME labeled.

2.02 DIAPHRAGM-TYPE COMPRESSION TANKS

- A. Manufacturers:
 - 1. Amtrol Inc.
 - 2. Bell & Gossett, a xylem brand.
 - 3. Taco, Inc.
 - 4. Substitutions: Or Approved Equal.
- B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.
- C. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psig.

2.03 IN-LINE CIRCULATOR PUMPS

- A. Manufacturers:
 - 1. Taco.
 - 2. Armstrong Fluid Technology.
 - 3. Bell & Gossett, a xylem brand.
 - 4. Substitutions: Or Approved Equal.
- B. Casing: Bronze, rated for 125 psig working pressure, with stainless steel rotor assembly.
- C. Impeller: Bronze.
- D. Shaft: Alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.
- E. Seal: Carbon rotating against a stationary ceramic seat.
- F. Performance: Refer to drawing schedule.

2.04 SUMP PUMPS

- A. Manufacturers:
 - 1. Liberty Pumps.
 - 2. Zoeller Company.
 - 3. Stancor Pumps.
 - 4. Substitutions: Or Approved Equal.
- B. Sump Pump: Provide pump and control systems capable of pumping water while containing oil. System designed to operate automatically.
 - 1. Pump: UL 778, Submersible type, cast iron construction, epoxy finish, stainless steel screws, guard and handle, lower and upper oil fed cast iron bearings, carbon and ceramic shaft seal, cast iron impeller, factory tested.
 - 2. Motor: Capable of operating continuously or intermittently, hermetically sealed, oil-filled, automatic reset thermal overload protection compartment, 3-wire, 15-foot power cord.
 - 3. Controls Package: Oil Tector™ pump switch, Oil Tector™ control panel, Liquid Smart Switch™, 115 volt piggyback power plug.
 - 4. Oil Tector™ pump switch: internal 20 amp relay, 304 stainless steel sensor probes.
 - 5. Oil Tector™ Control Panel: NEMA 4X lockable enclosure, motor start relay, HOA switch, horn silence and alarm test switch, circuit breaker protection, automatic alarm reset, yellow light on presence of oil in sump, white light on presence of water, high liquid 85 decible alarm, top mounted red alarm beacon light, 100 foot cord to wire to main control panel, high oil and high water level, remote dry contacts, Led lights indication power and pumps run function.
 - 6. Liquid Smart Sensor™: incorporate electro-optic and Oil Smart™ Sensor in single encapsulated unit.

2.05 ELECTRICAL WORK

- A. Provide electrical motor driven equipment specified complete with motors, motor starters, controls, and wiring.
- B. Electrical characteristics to be as specified or indicated.
- C. Supply manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices not shown.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.
- B. Coordinate with plumbing piping work to achieve operating system.
- C. Pumps:
 - 1. Ensure shaft length allows sump pumps to be located minimum 24 inches below lowest invert into sump pit and minimum 6 inches clearance from bottom of sump pit.
 - 2. Provide line sized isolating valve and strainer on suction and line sized soft seated check valve and balancing valve on discharge.
 - 3. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

END OF SECTION

**SECTION 22 40 00
PLUMBING FIXTURES****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Water closets.
- B. Water closet flush valves.
- C. Water closet carriers.
- D. Urinals.
- E. Urinal flush valves.
- F. Urinal carriers.
- G. Lavatories.
- H. Lavatory faucet.
- I. Lavatory trim.
- J. Lavatory carrier.
- K. Sinks.
- L. Sink faucet.
- M. Sink trim.
- N. Mop sinks.
- O. Mop sink faucet.
- P. Mop sink trim.
- Q. Electric water coolers.
- R. Electric water cooler trim.
- S. Electric water cooler carrier

1.02 RELATED REQUIREMENTS

- A. Section 07 92 00 - Joint Sealants: Sealing joints between fixtures and walls and floors.
- B. Section 12 36 00 - Countertops: Preparation of counters for sinks and lavatories.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design.
- B. ASTM C1822 - Standard Specification for Insulating Covers on Accessible Lavatory Piping.
- C. ASHRAE Std 18 - Methods of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration..
- D. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use.
- E. ASME A112.18.1 - Plumbing Supply Fittings.
- F. ASME A112.19.2 - Ceramic Plumbing Fixtures.
- G. ASME A112.19.5 - Flush Valves and Spuds for Water Closets, Urinals, and Tanks.
- H. ASSE 1070 - Performance Requirements for Water Temperature Limiting Devices.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- J. NSF 61 - Drinking Water System Components - Health Effects.
- K. NSF 372 - Drinking Water System Components - Lead Content.
- L. UL (DIR) - Online Certifications Directory.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- C. Manufacturer's Instructions: Indicate installation methods and procedures.
- D. Sustainable Design Documentation: Submit appropriate evidence that materials used in potable water systems comply with the specified requirements.
- E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Government's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept fixtures on site in factory packaging. Inspect for damage.
- B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.07 WARRANTY

- A. Provide five year manufacturer warranty for electric water cooler.

PART 2 PRODUCTS**2.01 GENERAL REQUIREMENTS**

- A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.
- B. Water Efficiency: EPA WaterSense label is required for all water closets, urinals, and lavatory faucets.

2.02 REGULATORY REQUIREMENTS

- A. Comply with applicable codes for installation of plumbing systems.
- B. Perform work in accordance with local health department regulations.
- C. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of installation.

2.03 FLUSH VALVE WATER CLOSETS

- A. Water Closets (WC-1): Vitreous china, ASME A112.19.2, wall hung, siphon jet flush action, china bolt caps.
 - 1. Bowl: ASME A112.19.2; 16.5 inches high with elongated rim.
 - 2. Flush Valve: Exposed (top spud).
 - 3. Flush Operation: Sensor operated.
 - 4. Handle Height: 44 inches or less.
 - 5. Supply Size: 1-1/2 inches.
 - 6. Color: White.
- B. Water Closets (WC-2): Vitreous china, ASME A112.19.2, wall hung, siphon jet flush action, china bolt caps.
 - 1. Bowl: ASME A112.19.2; 18 inches high with elongated rim.
 - 2. Flush Valve: Exposed (top spud).
 - 3. Flush Operation: Sensor operated.
 - 4. Handle Height: 44 inches or less.
 - 5. Supply Size: 1-1/2 inches.
 - 6. Manufacturers:

- a. American Standard, Inc.
 - b. Kohler Company.
 - c. Zurn Industries, Inc.
 - d. Substitutions: Or Approved Equal.
- C. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
 - 1. Sensor-Operated Type: Solenoid or motor-driven operator, low voltage hard-wired, infrared sensor with mechanical over-ride or over-ride push button.
 - 2. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.
 - 3. Manufacturers:
 - a. American Standard, Inc.
 - b. Zurn Industries, Inc.
 - c. Water closet and flush valve must be of the same manufacturer.
 - d. Substitutions: Or Approved Equal.
- D. Seats:
 - 1. Manufacturers:
 - a. American Standard, Inc.
 - b. Bemis Manufacturing Company.
 - c. Church Seat Company.
 - d. Zurn Industries, Inc.
 - e. Substitutions: Or Approved Equal.
 - 2. Solid white plastic, open front, extended back, self-sustaining hinge, brass bolts, elongated.
- E. Water Closet Carriers:
 - 1. Manufacturers:
 - a. Zurn Industries, Inc.
 - b. Jay R. Smith MFG. Co.
 - c. JOSAM Company.
 - d. Substitutions: Or Approved Equal.
 - 2. ASME A112.6.1M; adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

2.04 WALL HUNG URINALS

- A. Wall Hung Urinal Manufacturers:
 - 1. American Standard, Inc.
 - 2. Kohler Company.
 - 3. Zurn Industries.
 - 4. Substitutions: Or Approved Equal.
- B. Urinals: Vitreous china, ASME A112.19.2, wall hung with side shields and concealed carrier.
 - 1. Flush Volume: 0.125 gallons, maximum.
 - 2. Flush Style: Washout.
 - 3. Flush Valve: Exposed (top spud).
 - 4. Flush Operation: Sensor operated.
 - 5. Trap: Integral.
 - 6. Removable stainless steel strainer.
 - 7. Supply Size: 3/4 inch.
 - 8. Outlet Size: 2 inches.
- C. Flush Valves: ASME A112.18.1, diaphragm or piston type complete with vacuum breaker stops and accessories.
 - 1. Sensor-Operated Type: Solenoid or motor-driven operator, low voltage hard-wired, infrared sensor with mechanical over-ride or over-ride push button.
 - 2. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.

3. Manufacturers:
 - a. American Standard, Inc.
 - b. Zurn Industries, Inc.
 - c. Water closet and flush valve must be of the same manufacturer.
 - d. Substitutions: Or Approved Equal;.
- D. Carriers:
 1. Manufacturers:
 - a. Zurn Industries, Inc.
 - b. Jay R. Smith MFG. Co.
 - c. JOSAM Company.
 - d. Substitutions: Or Approved Equal.
 2. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

2.05 LAVATORIES

- A. Lavatory Manufacturers:
 1. American Standard, Inc.
 2. Kohler Company.
 3. Zurn Industries, Inc.
 4. Substitutions: Or Approved Equal.
- B. Vitreous China Wall Hung Basin: ASME A112.19.2; vitreous china wall hung lavatory, 18 1/2 x 17-inches minimum, with 4 inch high back, rectangular basin with splash lip, front overflow, and soap depression.
 1. Drilling Centers: 4 inch.
- C. Vitreous China Under-Mount Basin: ASME A112.19.2; vitreous china under-mount lavatory, front overflow, mounting kit and template by manufacturer.
 1. Bowl size: 17 1/8 x 14 1/8-inches
- D. Sensor Operated Faucet Manufacturers:
 1. American Standard, Inc.
 2. Kohler Company; _____.
 3. Zurn Industries, Inc.
 4. Substitutions: Or Approved E.
- E. Sensor Operated Faucet: UL 1310, ANSI A112.18.1 and ANSI 117.1; A/C powered, hard-wired power supply with 10 foot extension cable and multi-AC adapter and 10-inch extension cable, chrome-plated brass construction, 4-inch deck plate, programmable infrared proximity sensor, ceramic disc, electronic controls, sensor range adjustment screw, variable time-out settings, safety timer, integrated strainer, solenoid valve, chrome plated grid strainer with 1 1/4-inch outlet tube, metal jacket wire protection for sensor leads, two back checks for hot and cold supplies, 0.5 gpm flow with vandal resistant aerator, lead-free construction.
- F. Trim (P-Trap) Manufacturers:
 1. McGuire Manufacturing.
 2. T & S Brass.
 3. Brass Craft.
 4. Or Approved Equal.
- G. Trim (P-Trap):
- H. Drain: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon.
 1. Drain: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon.
 2. Offset waste with perforated open strainer.
- I. Trim (Supply Piping) Manufacturers:
 1. McGuire Manufacturing.
 2. T & S Brass.

- 3. Brass Craft.
- 4. Substitutions: Or Approved Equal.
- J. Trim (Supply Piping):
 - 1. Supply Piping: 3/8-inch quarter turn ball valve, 3/8-inch male threaded inlet, escutcheon, braided stainless steel riser, 1/2-inch inlet, chrome finish, lead free.
- K. Trim Insulation Package Manufacturers:
 - 1. Tru-Bro, Inc.Pro-WrapSubstitutions:
- L. Trim Insulation Package:
- M. Rigid high-impact, stain-resistant PVC, internal reusable fasteners, compatible with 1 1/4" or 1 1/2" p-traps assemblies and 3/8" or 1/2" angle stop assemblies, ASTM D 635 self-extinguishing characteristics, ASTM G21 and G22 bacteria/Fungus resistance.Chrome plated 17 gage, 0.0538 inch brass P-trap with clean-out plug and arm with escutcheon.Offset waste with perforated open strainer.Wheel handle stops.Rigid supplies.Carrier:
 - 1. Carrier:
 - a. Manufacturers:
 - 1) Zurn Industries, Inc
 - 2) Jay R. Smith MFG. Co.
 - 3) JOSAM Company.
 - 4) Substitutions: Or Approved Equal.
 - b. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded studs for fixture hanger, bearing plate and studs.

2.06 SINKS

- A. Sink Manufacturers:
 - 1. Elkay Mfg.
 - 2. Just Mfg
 - 3. Substitutions: Or Approved Equal.
- B. Single Compartment Bowl: ASME A112.19.3; 33" by 32" outside dimensions 20 gage, 0.0359 inch thick, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.
 - 1. Drain: 1-1/2 inch chromed brass drain.
 - 2. Drain: 3-1/2 inch crumb cup and tailpiece.
- C. Faucet Manufacturers:
 - 1. Elkay Mfg.
 - 2. Just Mfg. Co.
 - 3. Moen
 - 4. Substitutions: Or Approved Equal.
- D. Faucet:
 - 1. ASME A112.18.1, NSF 61 and NSF 372; chrome plated brass supply with 5" high gooseneck swing spout, water economy aerator with maximum 1.5 gpm flow, indexed 4" wrist blade handles, 4-inch on center fittings.
- E. Cup Strainer Manufacturer:Elkay Mfg.Just Mfg. Co.MoenSubstitutions: See Section 01 25 00 Substitution Procedures.Cup StrainerASME A112.18.2; Stainless steel strainer with removable basket with rubber seat stopper and 1 1/2-inch OD x 4-inch chrome brass tailpiece.Trim (P-trap) Manufacturers:McGuire Manufacturing.T & S Brass.Brass Craft.Substitutions: See Section 01 25 00 Substitution Procedures.Trim (P-trap)Adjustable cast brass P-trap, swivel-ell, 1 1/2-inch inlet, 1 1/2-inch outlet, cleanout plug, chrome finish.Trim (Supply Piping) Manufacturers:McGuire Manufacturing.T & S Brass.Brass Craft.Substitutions: See Section 01 25 00 Substitution Procedures.Trim (Supply Piping)3/8-inch quarter turn ball valve, 3/8-inch male threaded inlet, escutcheon, braided stainless steel riser, 1/2-inch inlet, chrome finish, lead-free.Drain: 1-1/2 inch chromed brass drain.Drain: 3-1/2 inch crumb cup and tailpiece.
 - 1. Elkay Mfg.

2. Just Mfg. Co.
 3. Moen.
 4. Substitutions: Or Approved Equal.
- F. Cup Strainer:
1. ASME A112.18.2; Stainless steel strainer with removable basket with rubber seat stopper and 1 1/2-inch OD x 4-inch chrome brass tailpiece.
- G. Trim (P-trap) Manufacturers:
- H. McGuire Manufacturing.T & S Brass.Brass Craft.Substitutions: See Section 01 25 00 Substitution Procedures.
- I. Trim (P-trap)Adjustable cast brass P-trap, swivel-ell, 1 1/2-inch inlet, 1 1/2-inch outlet, cleanout plug, chrome finish.
- J. Trim (Supply Piping) Manufacturers:
1. McGuire Manufacturing.
 2. T & S Brass.
 3. Brass Craft.
 4. Substitutions: Or Approved Equal.
- K. Trim (Supply Piping):
1. 3/8-inch quarter turn ball valve, 3/8-inch male threaded inlet, escutcheon, braided stainless steel riser, 1/2-inch inlet, chrome finish, lead-free.

2.07 BI-LEVEL, ELECTRIC WATER COOLERS

- A. Bi-level, Electric Water Cooler Manufacturers:
1. Elkay Manufacturing Company.
 2. Haws Corporation.
 3. Oasis International.
 4. Substitutions: Or Approved Equal.
- B. Water Cooler: Bi-level, electric, mechanically refrigerated; surface mounted, ADA compliant; stainless steel top, vinyl on steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket; integral air cooled condenser and stainless steel grille.
1. Capacity: 8 gallons per hour of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F, when tested in accordance with ASHRAE Std 18.
 2. Electrical: 115 V, 60 Hertz compressor, 6 foot cord and plug for connection to electric wiring system including grounding connector.
- C. Carrier Manufacturers:
1. Zurn Industries, LLC.
 2. Josam.
 3. J.R. Smith.
 4. Substitutions: Or Approved Equal.
- D. Carrier: ASME A112.6.1; Coated rectangular steel uprights with welded feet, adjustable top and bottom support plates and mounting fasteners.
- E. Trim (P-trap) Manufacturers:
1. McGuire Manufacturing.
 2. T & S Brass.
 3. Brass Craft.
 4. Substitutions: Or Approved Equal.
- F. Drain: Adjustable cast brass P-trap, swivel-ell, 1-1/2-inch inlet, 1-1/2-inch outlet, cleanout plug, chrome finish.
- G. Trim (Supplies and Stops) Manufacturers:
1. McGuire Manufacturing.

- 2. T & S Brass.
 - 3. Brass Craft.
 - 4. Substitutions: Or Approved Equal.
- H. Supplies and Stops: 3/8-inch quarter turn ball valve, 3/8-inch male threaded inlet, escutcheon, braided stainless steel riser, 1/2-inch inlet, chrome finish, lead free.

2.08 MOP SINKS

- A. Mop Sink Manufacturers:
 - 1. Fiat Products.
 - 2. Just Manufacturing Company.
 - 3. Substitutions: Or Approved Equal.
- B. Mop Service Basin: Floor mounted molded stone and resin one piece homogeneous unit, 24 x 24 x 10 inch size, with cadmium plated brass drain body and stainless steel combination dome strainer.
 - 1. Floor mounted molded stone and resin one piece homogeneous unit, 24 x 24 x 10 inch size, with cadmium plated brass drain body and stainless steel combination dome strainer.
- C. Faucet Manufacturers:
 - 1. Fiat Products.
 - 2. Just Manufacturing Company.
 - 3. Substitutions: Or Approved Equal.
- D. Fiat Products Acorn Engineering Company. Just Manufacturing Company. Substitutions: See Section 01 25 00 Substitution Procedures.
- E. Service Faucet: Chrome-plated with vacuum breaker, integral stops, wall brace, pail hook and 3/4" hose thread on spout, four arm handles, body inlets, 8" centers.
- F. Trim Manufacturers: Fiat Products Acorn Engineering Company. Just Manufacturing Company. Substitutions: See Section 01 25 00 Substitution Procedures.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- B. Verify that electric power is available and of the correct characteristics.
- C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.02 PREPARATION

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with wall supports and bolts.

3.04 INTERFACE WITH WORK OF OTHER SECTIONS

- A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.05 ADJUSTING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.06 CLEANING

- A. Clean plumbing fixtures and equipment.

3.07 PROTECTION

- A. Protect installed products from damage due to subsequent construction operations.
- B. Do not permit use of fixtures by construction personnel.
- C. Repair or replace damaged products before Date of Substantial Completion.

3.08 SCHEDULES

- A. Fixture Heights: Install fixtures to heights above finished floor as indicated.
 - 1. Water Closet:
 - a. Standard: 15 inches to top of bowl rim.
 - b. Accessible: 18 inches to top of seat.
 - 2. Water Closet Flush Valves:
 - a. Standard: 11 inches min. above bowl rim.
 - b. Recessed: 10 inches min. above bowl rim.
 - 3. Urinal:
 - a. Standard: 22 inches to top of bowl rim.
 - b. Accessible: 17 inches to top of bowl rim.
 - 4. Lavatory:
 - a. Standard: 31 inches to top of basin rim.
 - b. Accessible: 34 inches to top of basin rim.
 - 5. Water Cooler:
 - a. Standard Adult: 40 inches to top of basin rim.
 - b. Accessible: 36 inches to top of spout.
- B. Fixture Rough-In: Refer to Plumbing Fixture Schedule.

END OF SECTION

**SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. General construction and requirements.
- B. Applications.
- C. Single phase electric motors.
- D. Three phase electric motors.
- E. Electronically Commutated Motors (ECM).

1.02 REFERENCE STANDARDS

- A. NEMA MG 00001 - Motors and Generators.
- B. NFPA 70 - National Electrical Code.

1.03 SUBMITTALS

- A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- B. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- C. Operation Data: Include instructions for safe operating procedures.
- D. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacture of electric motors for use, and their accessories, with minimum 10 years documented product development, testing, and manufacturing experience.
- B. Comply with NFPA 70.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.06 WARRANTY

- A. Provide five year manufacturer warranty for motors larger than 5 horsepower.

PART 2 PRODUCTS**2.01 GENERAL CONSTRUCTION AND REQUIREMENTS**

- A. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Design for continuous operation in 104 degrees F environment.
 - 3. Design for temperature rise in accordance with NEMA MG 00001 limits for insulation class, service factor, and motor enclosure type.
- B. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- C. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.02 SINGLE PHASE POWER - SPLIT PHASE MOTORS

- A. Starting Torque: Less than 150 percent of full load torque.
- B. Starting Current: Up to seven times full load current.
- C. Breakdown Torque: Approximately 200 percent of full load torque.
- D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
- E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.03 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

- A. Starting Torque: Exceeding one fourth of full load torque.
- B. Starting Current: Up to six times full load current.
- C. Multiple Speed: Through tapped windings.
- D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.04 ELECTRONICALLY COMMUTATED MOTORS (ECM)

- A. Applications:
 1. Commercial:
 - a. Dedicated Outside Air Handling System
 - 1) Input: Motor manufacturer to coordinate control requirements with the control board of the roof top unit and/or specified sequence of operation.
 - 2) Shaft Extension: Single.
 - 3) RPM: 300 through 1200.
 - b. Air Handling Unit:
 - 1) Input: Motor manufacturer to coordinate control requirements with the control board of the roof top unit and/or specified sequence of operation.
 - 2) Shaft Extension: Single.
 - 3) RPM: 300 through 1200.
 - c. DX Fan Coil Unit:
 - 1) Input: Motor manufacturer to coordinate control requirements with the control board of the DX fan coil unit and/or specified sequence of operation.
 - 2) Shaft Extension: Single.
 - 3) RPM: 300 through 1250.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION

SECTION 23 05 17
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Pipe sleeves.
- B. Pipe-sleeve seals.

1.02 REFERENCE STANDARDS

- A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.

1.03 SUBMITTALS

- A. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum 10 years experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified this section.
 - 1. Minimum 5 experience.
 - 2. Approved by manufacturer.
- C. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.
- B. Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

1.06 WARRANTY

- A. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS**2.01 PIPE SLEEVES**

- A. Manufacturers:
 - 1. Advance Products & Systems, LLC; www.apsonline.com/#sle.
 - 2. Flexicraft Industries; www.flexicraft.com/#sle.
 - 3. Metraflex; www.metraflex.com/#sle.
- B. Vertical Piping:
 - 1. Sleeve Length: 1 inch above finished floor.
 - 2. Provide sealant for watertight joint.
 - 3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
 - 4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.
- C. Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
- D. Pipe Passing Through Below Grade Exterior Walls:
 - 1. Zinc coated or cast iron pipe.

2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
- E. Pipe Passing Through Mechanical Room Floors above grade:
 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 2. Connect sleeve with floor plate except in mechanical rooms.
- F. Clearances:
 1. Provide allowance for insulated piping.
 2. Wall, Floor, Partitions, and Beam Flanges: 1 inch greater than external pipe diameter.

2.02 PIPE-SLEEVE SEALS

- A. Manufacturers:
 1. Advance Products & Systems, LLC; Innerlynx: www.apsonline.com/#sle.
 2. Flexicraft Industries; PipeSeal: www.flexicraft.com/#sle.
- B. Modular Mechanical Sleeve-Seal:
 1. Elastomer-based interlocking links continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
 2. Watertight seal between pipe and wall-sleeve, wall or casing opening.
 3. Size and select seal component materials in accordance with service requirements.
 4. Glass-reinforced plastic pressure end plates.
- C. Sealing Compounds:
 1. Provide packing and sealing compound to fill pipe to sleeve thickness.
 2. Combined packing and seal compound is to match partition fire-resistance hourly rating.
- D. Pipe Sleeve Material:
 1. Bearing Walls: Steel, cast iron, or terra-cotta pipe.
 2. Masonry Structures: Sheet metal or fiber.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.

3.02 INSTALLATION

- A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- B. Install piping to conserve building space, to not interfere with use of space and other work.
- C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- D. Inserts:
 1. Provide inserts for placement in concrete formwork.
 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- E. Structural Considerations:
 1. Do not penetrate building structural members unless specifically indicated.
- F. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
 1. Underground Piping: Caulk pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.

2. Aboveground Piping:
 - a. Pack solid using mineral fiber in compliance with ASTM C592.
 - b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
 3. All Rated Openings: Caulk tight with fire stopping material in compliance with ASTM E814 to prevent the spread of fire, smoke, and gases.
 4. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.
- G. Manufactured Sleeve-Seal Systems:
1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
 3. Locate piping in center of sleeve or penetration.
 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 5. Tighten bolting for a water-tight seal.
 6. Install in accordance with manufacturer's recommendations.
- H. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.03 CLEANING

- A. Upon completion of work, clean all parts of the installation.
- B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION

SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Support and attachment components.

1.02 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
- F. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- G. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
- H. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- I. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- J. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- L. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- M. FM (AG) - FM Approval Guide.
- N. MFMA-4 - Metal Framing Standards Publication.
- O. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- P. UL (DIR) - Online Certifications Directory.
- Q. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.
- B. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
 - 1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.

1.04 QUALITY ASSURANCE

- A. Comply with applicable building code.

- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
 - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 4. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Hanger Rods:
 - 1. Threaded zinc-plated steel unless otherwise indicated.
 - 2. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch diameter.
 - b. Piping up to 1 inch: 1/4 inch diameter.
 - c. Piping larger than 1 inch: 3/8 inch diameter.
 - d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.
- C. Thermal Insulated Pipe Supports:
 - 1. General Requirements:
 - a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
 - b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
 - c. Pipe supports to be provided for nominally sized, 1/2 to 30 inch iron pipes.
 - d. Insulation inserts to consist of rigid phenolic foam insulation surrounded by a 360 degree, PVC jacketing.
 - 2. PVC Jacket:
 - a. Pipe insulation protection shields to be provided with a ball bearing hinge and locking seam.
 - b. Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with ASTM E96/E96M.
 - c. Thickness: 60 mil.
 - 3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.
- D. Pipe Supports:
 - 1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.

2. Operating Temperatures from 122 to 446 degrees F:
 - a. Overhead Support: MSS SP-58 Type 1 or 3 through 12, with appropriate saddle of MSS SP-58 Type 40 for insulated pipe.
 - b. Roller Support: MSS SP-58 Types 41 or 43 through 46, with appropriate saddle of MSS SP-58 Type 39 for insulated pipe.
- E. Pipe Stanchions:
 1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 2. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
 3. For pipe runs, use stanchions of same type and material where vertical adjustment is required for stationary pipe.
- F. Beam Clamps:
 1. MSS SP-58 types 19 through 23, 25 or 27 through 30 based on required load.
 2. Beam C-Clamp: MSS SP-58 type 23, malleable iron and steel with plain, stainless steel, and zinc finish.
 3. Small or Junior Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish. For inverted usage provide manufacturer listed size(s).
 4. Wide Mouth Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish.
 5. Centerload Beam Clamp with Extension Piece: MSS SP-58 type 30, malleable iron with plain finish.
 6. FM (AG) and UL (DIR) Approved Beam Clamp: MSS SP-58 type 19, plain finish,
 7. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
 8. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
- G. Riser Clamps:
 1. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
 2. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.
 3. Medium Split Horizontal Pipe Clamp: MSS SP-58 type 4, carbon steel or stainless steel with epoxy plated, plain, stainless steel, or zinc plated finish.
 4. Copper Tube Pipe Clamp: MSS SP-58 type 8, epoxy plated copper.
 5. UL (DIR) listed: Pipe sizes 1/2 to 8 inch.
- H. Insulation Clamps:
 1. Two bolt-type clamps designed for installation under insulation.
 2. Material: Carbon steel with epoxy copper or zinc finish.
- I. Pipe Hangers:
 1. Split Ring Hangers:
 - a. Provide hinged split ring and yoke roller hanger with epoxy copper or plain finish.
 - b. Material: ASTM A47/A47M malleable iron or ASTM A36/A36M carbon steel.
 - c. Provide hanger rod and nuts of the same type and material for a given pipe run.
 - d. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
 2. Band Hangers, Adjustable:
 - a. MSS SP-58 Type 7 or 9, Zinc-plated ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
 3. Swivel Ring Hangers, Adjustable:
 - a. MSS SP-58 Type 10, epoxy-painted, zinc-colored.
 - b. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.

- c. FM (AG) and UL (DIR) listed for specific pipe size runs and loads.
- 4. Clevis Hangers, Adjustable:
 - a. Copper Tube: MSS SP-58 Type 1, epoxy-plated copper.
 - b. Felt-Lined: MSS SP-58 Type 1, zinc-plated, silicone-free carbon steel.
 - c. Light-Duty: MSS SP-58 Type 1, zinc-colored, epoxy plated.
 - d. Standard-Duty: MSS SP-58 Type 1, zinc-colored, epoxy plated.
 - e. UL (DIR) listed: Pipe sizes 2-1/2 to 8 inch.
- J. Pipe Alignment Guides: Galvanized steel.
 - 1. Pipe Sizes 8 inch and Smaller: Spider or sleeve type.
 - 2. Pipe Sizes 10 inch and Larger: Roller type.
- K. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.
- L. Pipe Shields for Insulated Piping:
 - 1. General Construction and Requirements:
 - a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
 - b. Shields Material: UV-resistant polypropylene with glass fill.
 - c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
 - d. Minimum Service Temperature: Minus 40 degrees F.
 - e. Maximum Service Temperature: 178 degrees F.
 - f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
- M. Anchors and Fasteners:
 - 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 - 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 - 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 - 4. Hollow Masonry: Use toggle bolts.
 - 5. Hollow Stud Walls: Use toggle bolts.
 - 6. Steel: Use beam-ceiling clamps, beam clamps, machine bolts, or welded threaded studs.
 - 7. Beam Ceiling Flanges: ASTM A47/A47M Grade 32510, malleable iron or stainless steel with copper, plain, stainless steel, or zinc finish.
 - 8. Sheet Metal: Use sheet metal screws.
 - 9. Wood: Use wood screws.
 - 10. Plastic and lead anchors are not permitted.
 - 11. Powder-actuated fasteners are not permitted.
 - 12. Hammer-driven anchors and fasteners are not permitted.
 - 13. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
- N. Pipe Installation Accessories:
 - 1. Copper Pipe Supports:
 - 2. Thermal Insulated, Surface-Mounted Pipe Supports:
 - a. Material: Carbon steel with epoxy copper or zinc finish.
 - b. Weather and UV light resistant foam, plastic, or rubber material with built-in strut.
Maximum Load: 50 lb for single pipe or multiple landed on top strut.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.

- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- C. Unless specifically indicated or approved by Contracting Officer or Contracting Officer's Representative, do not provide support from suspended ceiling support system or ceiling grid.
- D. Unless specifically indicated or approved by Contracting Officer or Contracting Officer's Representative, do not provide support from roof deck.
- E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- F. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.
- G. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.
- I. Secure fasteners according to manufacturer's recommended torque settings.
- J. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

- A. Inspect support and attachment components for damage and defects.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Pipe markers.
- E. Ceiling tacks.

1.02 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials.

1.03 SUBMITTALS

- A. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS**2.01 IDENTIFICATION APPLICATIONS**

- A. Air Handling Units: Nameplates.
- B. Branch Selector Boxes: Ceiling tacks where located above lay-in ceiling.
- C. Dedicated Outside Air Systems: Nameplates
- D. Ceiling Cassette Units: Equipment Tags.
- E. Condensate piping: Pipe Markers.
- F. Outdoor Heat Pumps: Nameplates.
- G. Outdoor Heat Recovery Units: Nameplates.
- H. Ducted Concealed Units: Equipment Tags.
- I. Air Terminal Units: Equipment Tags.
- J. Automatic Controls: Tags. Key to control schematic.
- K. Control Panels: Nameplates.
- L. Dampers: Ceiling tacks, where located above lay-in ceiling.
- M. Ductwork: Duct Markers.
- N. Instrumentation: Tags.
- O. Major Control Components: Nameplates.
- P. Refrigerant piping: Pipe markers.
- Q. Small-sized Equipment: Equipment Tags.
- R. Tanks: Nameplates.
- S. Thermostats: Equipment Tags Nameplates.

2.02 NAMEPLATES

- A. Manufacturers:
 - 1. Advanced Graphic Engraving, LLC: www.advancedgraphicengraving.com/#sle.
 - 2. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 3. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 4. Seton Identification Products, a Tricor Direct Company: www.seton.com/#sle.
- B. Letter Color: White.

- C. Letter Height: 1/4 inch.
- D. Background Color: Black.
- E. Plastic: Comply with ASTM D709.
- F. Nameplate minimum: 1" by 2.5" inches

2.03 VALVE TAGS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradycorp.com/#sle.
 - 2. Brimar Industries, Inc: www.pipemarker.com/#sle
 - 3. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 4. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
- B. Metal Tags: Brass with stamped letters; tag size minimum 1-3/8" diameter with smooth edges.
- C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame

2.04 EQUIPMENT TAGS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradycorp.com/#sle.
 - 2. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 3. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 4. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
- B. Plastic Tags: Laminated three-layer plastic with engraved White letters on black background color. Tag size minimum 1" x 2.5" rectangular.
- C. Metal Tags: Stainless Steel with stamped letters; tag size minimum 1x2.5 inches rectangular with smooth edges.

2.05 ADHESIVE-BACKED DUCT MARKERS

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 2. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 3. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
- B. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.
- C. Style: Individual Label.
- D. Color: Yellow/Black.

2.06 PIPE MARKERS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradycorp.com/#sle.
 - 2. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 3. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 4. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
- B. Color: Comply with ASME A13.1.
- C. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Color code as follows:
 - 1. Refrigerant Suction: Yellow with black letters.
 - 2. Refrigerant Liquid: Yellow with black letters.
 - 3. Condensate: Green with white letters.
 - 4. Compressed Air: Blue with white letters.
 - 5. (Humidifier) Steam Piping: Yellow with black letters.

2.07 CEILING TACKS

- A. Manufacturers:
 - 1. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
- B. Description: Steel with 3/4 inch diameter color coded head.
- C. Color code as follows:
 - 1. HVAC Equipment: Yellow.
 - 2. Fire Dampers and Smoke Dampers: Red.
 - 3. Heating/Cooling Valves: Blue.

PART 3 EXECUTION**3.01 PREPARATION**

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- E. Use tags on piping 3/4 inch diameter and smaller.
 - 1. Identify service, flow direction, and pressure.
 - 2. Install in clear view and align with axis of piping.
 - 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- F. Install ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- G. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Testing, adjustment, and balancing of air systems.
- B. Measurement of final operating condition of HVAC systems.

1.02 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition.
- B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.
- C. NEBB (TAB) - Procedural Standards for Testing Adjusting and Balancing of Environmental Systems.
- D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing.

1.03 SUBMITTALS

- A. TAB Agency Qualifications: Submit names and certifications of testing, adjusting and balancing agency and TAB supervisor and technicians for approval within 30 days after award of Contract.
- B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Submit to Contracting Officer or Contracting Officer's Representative.
 - 2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
 - 3. Include at least the following in the plan:
 - a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, and formulas to be used.
 - b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - c. Identification and types of measurement instruments to be used and their most recent calibration date.
 - d. Final test report forms to be used.
 - e. Procedures for formal deficiency reports, including scope, frequency and distribution.
- C. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 2. Submit draft copies of report for review prior to final acceptance of Project.
 - 3. Provide four certified final copies of report, signed by Test and Balance Supervisor who performed TAB work, for Contracting Officer or Contracting Officer's Representative and for inclusion in operating and maintenance manuals.
 - 4. Include actual instrument list, with manufacturer name, serial number, and date of calibration. Provide copies of calibration certificates.
 - 5. System test reports shall include the following data:
 - a. Fan Performance (Designed and Measured):
 - 1) CFM
 - 2) Static Pressure, Total
 - 3) Fan RPM
 - 4) Motor RPM
 - 5) Amps
 - 6) Volts
 - 7) Drive data

- b. System Performance (Designed and Measured):
 - 1) CFM at Each Outlet
 - 2) Return Air at Fan
 - 3) Supply Air Temperature
 - 4) Return Air Temperature
 - 5) Outside Air Temperature
- 6. Include pressure profiles report through all system components, including plenums, coils, filters, etc. with a system sketch indicating locations where readings were taken.
- 7. Include actual pressure difference manometer readings with corresponding static pressure sensor readings.
- 8. Space pressurization test reports shall include blower door reports for air quantities at positive and negative pressures.
- 9. Duct leakage reports shall indicate percentage according to pressure class in accordance with ASHRAE.
- 10. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC (NSTSB), AABC National Standards for Total System Balance.
 - 2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 - 3. Maintain at least one copy of the standard to be used at project site at all times.
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Instruments used shall be accurately calibrated and maintained in good working order.
- D. Install and adjust equipment per the manufacturer's instructions and recommendations. Follow all operating and installation manuals.
- E. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- F. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Having minimum of 10 years documented experience.
 - 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
- G. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris, dirt, and discarded building materials.

6. Fans are rotating correctly.
 7. Volume dampers are in place and open.
 8. Air coil fins are cleaned and combed.
 9. Access doors are closed and duct end caps are in place.
 10. Air outlets are installed and connected.
 11. Duct system leakage is minimized.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- B. Provide additional balancing devices as required.

3.04 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- D. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.06 AIR SYSTEM PROCEDURE

- A. Before final adjustments and balancing, operate system for a minimum of four (4) hours. After this period, remove filters and clean supply and return ducts, grilles, registers, diffusers, and coil surfaces in unit, using a vacuum cleaner and brush. Install clean filters and balance system. Balance system with pressure drop from average filter loading taken into account.
- B. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.
- C. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- D. Measure air quantities at air inlets and outlets.
- E. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- F. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- G. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- H. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

- I. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- J. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- K. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- L. Where modulating dampers are provided, take measurements and balance at maximum airflow indicated on contract drawings.
- M. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

3.07 SCOPE

- A. Test, adjust, and balance the following:
 - 1. Plumbing Pumps
 - 2. VRF Heat Recovery Units
 - 3. Ductless Split Units
 - 4. (Relocated) Air Handling Unit
 - 5. Dedicated Outside Air System (DOAS) Units
 - 6. Airflow Monitoring Stations
 - 7. Air Coils
 - 8. Exhaust Fan
 - 9. Unit Heaters
 - 10. Electric Wall Heaters
 - 11. Air Terminal Units.
 - a. Ceiling Cassette Units
 - b. Concealed Ducted Units
 - 12. Air Inlets and Outlets.

3.08 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 - 1. Manufacturer.
 - 2. Model/Frame.
 - 3. HP/BHP.
 - 4. Phase, voltage, amperage; nameplate, actual, no load.
 - 5. RPM.
 - 6. Service factor.
 - 7. Starter size, rating, heater elements.
 - 8. Sheave Make/Size/Bore.
- B. Pumps:
 - 1. Identification/number.
 - 2. Manufacturer.
 - 3. Size/model.
 - 4. Impeller.
 - 5. Service.
 - 6. Design flow rate, pressure drop, BHP.
 - 7. Actual flow rate, pressure drop, BHP.
 - 8. Discharge pressure.
 - 9. Suction pressure.
 - 10. Total operating head pressure.
 - 11. Shut off, discharge and suction pressures.
 - 12. Shut off, total head pressure.

- C. Electric Unit Heaters:
 - 1. Manufacturer.
 - 2. Identification/number.
 - 3. Location.
 - 4. Model number.
 - 5. Design kW.
 - 6. Number of stages.
 - 7. Phase, voltage, amperage.
 - 8. Test voltage (each phase).
 - 9. Test amperage (each phase).
 - 10. Air flow, specified and actual.
 - 11. Temperature rise, specified and actual.
- D. Electric Wall Heaters:
 - 1. Manufacturer.
 - 2. Identification/number.
 - 3. Location.
 - 4. Model number.
 - 5. Design kW.
 - 6. Number of stages.
 - 7. Phase, voltage, amperage.
 - 8. Test voltage (each phase).
 - 9. Test amperage (each phase).
 - 10. Air flow, specified and actual.
 - 11. Temperature rise, specified and actual.
- E. Dedicated Outside Air System:
 - 1. Location.
 - 2. Manufacturer.
 - 3. Model number.
 - 4. Serial number.
 - 5. Arrangement/Class/Discharge.
 - 6. Air flow, specified and actual.
 - 7. Exhaust air flow, specified and actual.
 - 8. Outside air flow, specified and actual.
 - 9. Supply air flow, specified and actual.
 - 10. Exhaust air flow, specified and actual.
 - 11. Total static pressure (total external), specified and actual.
 - 12. Inlet pressure.
 - 13. Discharge pressure.
 - 14. Supply Fan RPM.
 - 15. Exhaust Fan RPM.
 - 16. Energy wheel leaving air temperature
 - 17. Design Motor Horsepower
 - 18. Actual Motor Horsepower
- F. Exhaust Air / Return Air / Outside Air
 - 1. Identification/location.
 - 2. Design air flow.
 - 3. Actual air flow.
 - 4. Design return air flow.
 - 5. Actual return air flow.
 - 6. Design outside air flow.
 - 7. Actual outside air flow.
 - 8. Return air temperature.

9. Outside air temperature.
 10. Required mixed air temperature.
 11. Actual mixed air temperature.
 12. Design outside/return air ratio.
 13. Actual outside/return air ratio.
- G. Exhaust Fans:
1. Location.
 2. Manufacturer.
 3. Model number.
 4. Serial number.
 5. Air flow, specified and actual.
 6. Total static pressure (total external), specified and actual.
 7. Inlet pressure.
 8. Discharge pressure.
 9. Fan RPM.
 10. Design Motor Horsepower
 11. Actual Motor Horsepower
- H. Duct Traverses:
1. System zone/branch.
 2. Duct size.
 - a. Width
 - b. Height
 - c. Area
 3. Design velocity.
 4. Design air flow.
 5. Test velocity.
 6. Test air flow.
 7. Duct static pressure.
 8. Air temperature.
 9. Air correction factor.
- I. Duct Leak Tests:
1. Description of ductwork under test.
 2. Duct design operating pressure.
 3. Duct design test static pressure.
 4. Duct capacity, air flow.
 5. Maximum allowable leakage duct capacity times leak factor.
 6. Test apparatus:
 - a. Blower.
 - b. Orifice, tube size.
 - c. Orifice size.
 - d. Calibrated.
 7. Test static pressure.
 8. Test orifice differential pressure.
 9. Leakage.
- J. Airflow Measuring Stations:
1. Identification/number.
 2. Location.
 3. Size.
 4. Manufacturer.
 5. Model number.
 6. Serial number.

7. Design Flow rate.
 8. Design pressure drop.
 9. Actual/final pressure drop.
 10. Actual/final flow rate.
 11. Station calibrated setting.
- K. Terminal Unit Data:
1. Identification/number.
 2. Type, constant, variable, single duct.
 3. Location.
 4. Manufacturer
 5. Model number.
 6. Serial number.
 7. Size.
 8. Minimum static pressure.
 9. Minimum design air flow.
 10. Maximum design air flow.
 11. Maximum actual air flow.
 12. Inlet static pressure.
 13. Outside airflow rate
 14. Return airflow rate
 15. Supply Airflow rate
- L. Air Distribution Tests:
1. Air terminal number.
 2. Room number/location.
 3. Terminal type.
 4. Terminal size.
 5. Area factor.
 6. Design velocity.
 7. Design air flow.
 8. Test (final) velocity.
 9. Test (final) air flow.
 10. Percent of design air flow.
- M. VRF Heat Recovery Units
1. Identification/number.
 2. Manufacturer.
 3. Model Number
 4. Serial Number
 5. Location.
 6. Size.
 7. Design Motor Horsepower
 8. Actual Motor Horsepower

END OF SECTION

**SECTION 23 07 13
DUCT INSULATION****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Duct insulation.
- B. Weather barrier coatings.
- C. Jacketing and accessories.

1.02 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- B. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- C. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- D. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- E. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation.
- F. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- G. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
- H. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
- I. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.
- J. ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation.
- K. ASTM C1775 - Standard Specification for Laminate Protective Jacket and Tape for Use Over Thermal Insulation for Outdoor Applications.
- L. ASTM D5590 - Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay.
- M. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- N. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- O. SAE AMS3779 - Tape, Adhesive, Pressure-Sensitive Thermal Radiation Resistant, Aluminum Coated Glass Cloth.
- P. UL 181A - Closure Systems for Use with Rigid Air Ducts.
- Q. UL 181B - Closure Systems for Use with Flexible Air Ducts and Air Connectors.
- R. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.
- C. Sustainability Report: Submit a LEED Submittal Form for each different product stating:
 - 1. VOC content of each adhesive and/or sealant.

2. State the total recycled content, broken down into Post Consumer and Post Industrial percentages
3. State the location where each component as well as the final product is extracted/harvested/recovered and manufactured within 500 miles (800 km) of the project site.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.06 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS MINERAL WOOL, BLANKET

- A. Manufacturer:
 1. CertainTeed Corporation: www.certainteed.com/#sle.
 2. Johns Manville: www.jm.com/#sle.
 3. Knauf Insulation: www.knaufinsulation.com/#sle.
 4. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
 1. K value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
 2. Maximum Service Temperature: 1,200 degrees F.
 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
 4. Greenguard Indoor Air Quality Certified.
 5. Greenguard Gold certified.
 6. Recycled glass content: 50% minimum.
 7. Maximum Flame Spread: 25 per ASTM E84.
 8. Maximum Smoke Development Index: 50 per ASTM E84.
- C. Vapor Barrier Jacket:
 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 3. Secure with pressure-sensitive tape.
- D. Vapor Barrier Tape:
 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.
- E. Indoor Vapor Barrier Mastic:
 1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

2.03 GLASS FIBER, DUCT WRAP

- A. Manufacturer:

1. CertainTeed Corporation: www.certainteed.com/#sle
 2. Johns Manville: www.jm.com/#sle.
 3. Knauf Insulation: www.knaufinsulation.com/#sle.
 4. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
1. K value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
 2. Maximum Service Temperature: 250 degrees F.
 3. Maximum Water Vapor Absorption: Less than 5.0 percent by weight.
 4. Greenguard Gold certified.
 5. Formaldehyde free validated.
 6. Recycled Content:
 - a. SCS Global Services certified.
 7. Maximum Flame Spread: 25 per ASTM E84.
 8. Maximum Smoke Development Index: 50 per ASTM E84.
 9. Fungi resistance: Conforms to ASTM C1338..
- C. Vapor Barrier Jacket:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.
- D. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.
- E. Indoor Vapor Barrier Mastic:
1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

2.04 FIBERGLASS, DUCTBOARD

- A. Manufacturer:
1. CertainTeed Corporation: www.certainteed.com/#sle.
 2. Johns Manville: www.jm.com/#sle.
 3. Knauf Insulation: www.knaufinsulation.com/#sle.
 4. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
- B. Insulation: ASTM C612; rigid, noncombustible blanket.
1. K Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
 2. Maximum Service Temperature: 450 degrees F.
 3. Maximum Water Vapor Absorption: 5.0 percent.
 4. Minimum Density: 3.8 pcf.
 5. Greenguard Indoor Air Quality Certified.
 6. Recycled Content:
 - a. SCS Global Services certified to contain minimum 50% recycled glass content, minimum 30% pre-consumer recycled content, and minimum 20% post-consumer content.
 7. Maximum Smoke Development Index: 50 per ASTM E84.
 8. Meets UL181, Standard for Factory-made Air Ducts and Air Connectors.
- C. Vapor Barrier Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 3. Secure with pressure-sensitive tape.
- D. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.

2.05 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
 - 4. Greenguard Gold certified. Conforms to UL 2818.
- B. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
- C. Weather Barrier Coating: Air dried, contact adhesive, compatible with insulation and ASTM E84 compliant.

2.06 WEATHER BARRIER COATINGS

- A. Weather-Resistive Barrier Coating: Fire-resistive, UV resistant, water-based mastic for use over closed cell polyethylene and polyurethane foam insulation; applied with glass fiber or synthetic reinforcing mesh.
 - 1. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less, Class A, when tested in accordance with ASTM E84.
 - 2. Water Vapor Permeance: Greater than 1.0 perm in accordance with ASTM E96/E96M.
 - 3. Resistance to Fungal Growth: No growth when tested in accordance with ASTM D5590.

2.07 JACKETING AND ACCESSORIES

- A. Aluminum-Foil Laminate Jacket:
 - 1. Factory-applied, pressure sensitive adhesive jacketing on paper release liner.
 - 2. Finish: Aluminum smooth.
 - 3. Comply with ASTM C1775.
- B. Flexible Weather-Proofing Outdoor Jacket: Self-healing, field-applied outdoor cladding.
 - 1. Material: Aluminum foil/polymer laminate with rubberized asphalt layer and acrylic adhesive.
 - 2. Thickness: 34 mil, 0.034 inch.
 - 3. Finish: Embossed.
 - 4. Color: Silver.
 - 5. Water Vapor Transmission: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - 6. Mold Resistance: Pass when tested in accordance with ASTM C1338.
 - 7. Emissivity: 0.30 when tested in accordance with ASTM C1371.
- C. Reinforced Tape:
 - 1. FSK tape suitable for sealing seams between insulation, insulated elbows, and fittings resulting in a tight, smooth surface without wrinkles.
 - 2. Comply with UL 723 or ASTM E84.
 - 3. Moisture Vapor Permeability: 0.00 perm inch, when tested in accordance with ASTM E96/E96M.
- D. UL181 Tape for Rigid and Flexible Ductwork:
 - 1. Comply with UL 181A for rigid ductwork.
 - 2. Comply with UL 181B for flexible ductwork.
 - 3. Aluminum foil coated with pressure-sensitive adhesive on paper release liner.
 - 4. Foil tape suitable for sealing seams between insulation, insulated elbows, and fittings resulting in a tight, smooth surface without wrinkles.

2.08 DUCT LINER

- A. Do not provide duct liner.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Test ductwork for design pressure prior to applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Insulated Ducts Conveying Air Below Ambient Temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system, including fittings, joints, flanges, flexible connections, and expansion joints.
- C. Insulated Ducts Conveying Air Above Ambient Temperature:
 - 1. Provide with or without standard vapor barrier jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- D. Exterior Rooftop Applications: Provide insulation with vapor barrier jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.
- E. Slope exterior ductwork insulation to shed water.
- F. External Duct Insulation Application:
 - 1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 - 2. Secure insulation without vapor barrier with staples, tape, or wires.
 - 3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
 - 4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 - 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

END OF SECTION

**SECTION 23 07 19
HVAC PIPING INSULATION**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Piping insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Weather barrier coatings.
- D. Jacketing and accessories.
- E. Engineered wall outlet seals and refrigerant piping insulation protection.

1.02 REFERENCE STANDARDS

- A. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- B. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- E. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- F. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- G. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension.
- H. ASTM D570 - Standard Test Method for Water Absorption of Plastics.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- J. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- K. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- L. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
- M. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials.
- N. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- O. ASTM G153 - Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials.
- P. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.
- C. Sustainability Report: Submit a LEED Submittal Form for each different product stating:

1. VOC content of each adhesive and/or sealant.
2. State the total recycled content, broken down into Post Consumer and Post Industrial percentages.
3. State the location where each component as well as the final product is extracted/harvested/recovered and manufactured within 500 miles (800 km) of the project site.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 3 years of experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.06 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 FIBERGLASS, FLEXIBLE

- A. Manufacturers:
 1. Knauf Insulation
 2. Owens Corning
 3. Or Approved Equal
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
 1. K Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
 2. Maximum Service Temperature: 1,000 degrees F.
 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket:
 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
- D. Greenguard Gold certified, Conforms to UL 2818.
- E. Validated to be formaldehyde free.
- F. Recycled Content:
 1. SCS Global Services certified,
 - a. Total Product Recycled Content: 28%
 - b. Glass Only Recycled Content: 41%.
 - c. Minimum 30% post-consumer recycled content.
- G. Flame Spread Index: Less than 25.
- H. Smoke Development Index: Less than 50.
- I. Applications:
 1. Condensate piping.
 2. (Humidifier) steam distribution piping.

2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturers:
 - 1. Armacell
 - 2. Aeroflex
 - 3. K-flex.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
 - 4. Greenguard Gold certified. Conforms to UL 2818.
 - 5. Tested, rated, and labeled to ASTM C518.
 - 6. Flame Spread Index: Less than 25, conforms to ASTM E84.
 - 7. Smoke Development Index: Less than 50, conforms to ASTM E84.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
- D. Protective coating for exterior applications: Acrylic paint from elastomeric insulation manufacturer.
- E. Application:
 - 1. Refrigerant suction, refrigerant gas, and refrigerant liquid piping.

2.04 WEATHER BARRIER COATINGS

- A. Weather-Resistive Barrier Coating: Fire-resistive, UV resistant, water-based acrylic mastic for use over closed cell polyethylene and polyurethane foam insulation.
 - 1. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less, Class A, when tested in accordance with ASTM E84.

2.05 JACKETING AND ACCESSORIES

- A. PVC Plastic.
 - 1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil, 0.010 inch.
 - e. Connections: Brush on welding adhesive.
- B. Aluminum Jacket:
 - 1. Formed aluminum sheet complying with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
 - 2. Thickness: 0.020 inch sheet.
 - 3. Finish: Embossed.
 - 4. Joining: Longitudinal slip joints and 2 inch laps.
 - 5. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
 - 6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

2.06 ENGINEERED WALL OUTLET SEALS AND REFRIGERANT PIPING INSULATION PROTECTION

- A. Pipe Penetration Wall Seal: Seals HVAC piping wall penetrations with compression gasket wall mounted rigid plastic outlet cover.
 - 1. Wall Outlet Size, Stucco and Masonry Applications: 7-1/2 inch wide by 10 inch high.
 - a. Elastomeric Sleeve Diameter: 1-11/16 inch.
 - 2. Outlet Cover Color: Gray.
 - 3. Water Penetration: Comply with ASTM E331.

4. Air Leakage: Comply with ASTM E283.
5. Air Permeance: Comply with ASTM E2178.
- B. Insulation Protection System: Refrigerant piping insulation PVC protective cover.
 1. PVC Insulation Cover Color: Black with full-length velcro fastener.
 2. Weatherization and Ultraviolet Exposure Protection: Comply with ASTM G153.
 3. Water/Vapor Permeability: Comply with ASTM E96/E96M.
 4. Anti-Fungal and Anti-Microbial Resistance: Comply with ASTM G21.
 5. Flame Spread and Smoke Development Rating of 24/450: Comply with ASTM E84 or UL 723.
 6. Carbon Arc Light Exposure: Comply with ASTM G153.
 7. Tensile Strength After UV Exposure and Water Immersion: Comply with ASTM D412.
 8. Water Absorption of Plastics: Comply with ASTM D570.
 9. Adhesive free.

2.07 ACCESSORIES

- A. General Requirements:
 1. Provide required accessories in accordance with and subject to the recommendations of the insulation manufacturer.
 2. Furnish compatible materials which do not contribute to corrosion, soften, or otherwise attack surfaces to which applied, in either the wet or dry state.
 3. Comply with ASTM C795 requirements for materials to be used on stainless steel surfaces.
 4. Supply materials that are asbestos free.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Test piping for design pressure, liquid tightness, and continuity prior to applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Insulated Pipes Conveying Fluids Below Ambient Temperature:
 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- D. Elastomeric Insulated Pipes:
 1. Surfaces to be glued must be clean and free of grease.
 2. Secure with longitudinal lap and bond to pipe with manufacturer's contact adhesive. Secure with outward clinch expanding staples.
 3. Provide elastomeric foam tape to cover gaps or seal insulated sections.
 4. Seal all seams, butt joints, termination points and open ends.
- E. Fiberglass Insulated Pipes for Humidifier Steam Distribution:
 1. Provide standard jackets, with vapor barrier, factory-applied, or field-applied. Secure with longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth.
- F. Fiberglass Insulated Pipes Conveying Fluids Below Ambient Temperature:
 1. Provide vapor barrier jackets, factory-applied or field-applied; secure with longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.

2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- G. Inserts and Shields:
1. Application: Piping 1-1/2 inches diameter or larger.
 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 3. Insert location: Between support shield and piping and under the finish jacket.
 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- H. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 84 00.
- I. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers or aluminum jacket.
- J. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation and PVC jacketing over insulation or provide aluminum jacketing.

END OF SECTION

**SECTION 23 08 00
COMMISSIONING OF HVAC**

PART 1 GENERAL**1.01 SUMMARY**

- A. See Section 01 91 13 - General Commissioning Requirements for overall objectives; comply with the requirements of Section 01 91 13.
- B. This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.
- C. The Commissioning Authority (CA) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.
- D. The entire HVAC system is to be commissioned, including commissioning activities for the following specific items:
 - 1. Control system.
 - 2. Major and minor equipment items.
 - 3. Piping systems and equipment.
 - 4. Ductwork and accessories.
 - 5. Dedicated Outside Air System (DOAS).
 - 6. (Relocated) Air Handling Unit, AH-2
 - 7. Relocated Humidifier.
 - 8. Terminal units.
 - 9. Exhaust Fans.
 - 10. Electric Unit Heaters
 - 11. Electric Wall Heaters
 - 12. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.
- E. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.02 REFERENCE STANDARDS

- A. ASHRAE Guideline 1.1 - HVAC&R Technical Requirements for the Commissioning Process.

1.03 SUBMITTALS

- A. Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.
- B. Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of Commissioning Authority.
- C. HVAC Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:
 - 1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the detailed technical manual for programming and customizing control loops and algorithms.
 - 2. Full as-built set of control drawings.
 - 3. Full as-built sequence of operations for each piece of equipment.
 - 4. Full points list; in addition to the information on the original points list submittal, include a listing of all rooms with the following information for each room:
 - a. Floor.
 - b. Room number.

- c. Room name.
 - d. Air handler unit ID.
 - e. Reference drawing number.
 - f. Air terminal unit tag ID.
 - g. Heating and/or cooling valve tag ID.
 - h. Minimum air flow rate.
 - i. Maximum air flow rate.
5. Full print out of all schedules and set points after testing and acceptance of the system.
6. Full as-built print out of software program.
7. Electronic copy on disk of the entire program for this facility.
8. Marking of all system sensors and thermostats on the as-built floor plan and HVAC drawings with their control system designations.
9. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
10. Control equipment component submittals, parts lists, etc.
11. Warranty requirements.
12. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
13. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
 - a. Sequences of operation.
 - b. Control drawings.
 - c. Points lists.
 - d. Controller and/or module data.
 - e. Thermostats and timers.
 - f. Sensors and DP switches.
 - g. Valves and valve actuators.
 - h. Dampers and damper actuators.
 - i. Program setups (software program printouts).
- D. Project Record Documents: See Section 01 78 00 for additional requirements.
 1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
 2. Show actual locations of all static and differential pressure sensors (air, water and building pressure) and air-flow stations on project record drawings.
- E. Draft Training Plan: In addition to requirements specified in Section 01 79 00, include:
 1. Follow the recommendations of ASHRAE Guideline 1.1.
 2. Control system manufacturer's recommended training.
 3. Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC control system.
- F. Training Manuals: See Section 01 79 00 for additional requirements.
 1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

- A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Government.
- B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as

part of the work at no extra cost to Government; such equipment, tools, and instruments are to become the property of Government.

PART 3 EXECUTION

3.01 PREPARATION

- A. Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.
- B. Furnish additional information requested by the Commissioning Authority.
- C. Prepare a preliminary schedule for HVAC pipe and duct system testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by the Commissioning Authority; update the schedule as appropriate.
- D. Notify the Commissioning Authority when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that the Commissioning Authority has the scheduling information needed to efficiently execute the commissioning process.
- E. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.
- F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.
- G. Provide temperature and pressure taps in accordance with Contract Documents.

3.02 INSPECTING AND TESTING - GENERAL

- A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.
- B. Perform the Functional Tests directed by the Commissioning Authority for each item of equipment or other assembly to be commissioned.
- C. Provide two-way radios for use during the testing.
- D. Valve/Damper Stroke Setup and Check:
 - 1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
 - 2. Set pump/fan to normal operating mode.
 - 3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
 - 4. Command valve/damper open; verify position is full open and adjust output signal as required.
 - 5. Command valve/damper to a few intermediate positions.
 - 6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).
- E. Isolation Valve or System Valve Leak Check: For valves not by coils.
 - 1. With full pressure in the system, command valve closed.
 - 2. Use an ultra-sonic flow meter to detect flow or leakage.
- F. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Government.

3.03 TAB COORDINATION

- A. TAB: Testing, adjusting, and balancing of HVAC.
- B. Coordinate commissioning schedule with TAB schedule.
- C. Review the TAB plan to determine the capabilities of the control system toward completing TAB.

- D. Provide all necessary unique instruments and instruct the TAB technicians in their use; such as handheld control system interface for setting terminal unit boxes, etc.
- E. Have all required Prefunctional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by the Commissioning Authority prior to starting TAB.
- F. Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.

3.04 CONTROL SYSTEM FUNCTIONAL TESTING

- A. Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.
- B. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.
- C. Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Authority.
- D. Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
 - 1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Government.
 - 2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.
- E. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.
- F. Demonstrate the following to the Commissioning Authority during testing of controlled equipment; coordinate with commissioning of equipment.
 - 1. Setpoint changing features and functions.
 - 2. Sensor calibrations.
- G. Demonstrate to the Commissioning Authority:
 - 1. That all specified functions and features are set up, debugged and fully operable.
 - 2. That scheduling features are fully functional and setup, including holidays.
 - 3. That all graphic screens and value readouts are completed.
 - 4. Correct date and time setting in central computer.
 - 5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent; if any of those fail test all remaining units at no extra cost to Government.
 - 6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Government.
 - 7. Power failure and battery backup and power-up restart functions.
 - 8. Global commands features.
 - 9. Security and access codes.
 - 10. Occupant over-rides (manual, telephone, key, keypad, etc.).
 - 11. O&M schedules and alarms.
 - 12. Occupancy sensors and controls.
 - 13. All control strategies and sequences not tested during controlled equipment testing.

- H. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Government.

3.05 OPERATION AND MAINTENANCE MANUALS

- A. See Section 01 78 00 for additional requirements.
- B. Add design intent documentation furnished by Contracting Officer or Contracting Officer's Representative to manuals prior to submission to Government.
- C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.
- D. Commissioning Authority will add commissioning records to manuals after submission to Government.

3.06 DEMONSTRATION AND TRAINING

- A. See Section 01 79 00 for additional requirements.
- B. Demonstrate operation and maintenance of HVAC system to Government' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.
- C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.
- D. Provide classroom and hands-on training of Government's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned. Provide the following minimum durations of training:
- E. TAB Review: Instruct Government's personnel for minimum ____ hours, after completion of TAB, on the following:
 - 1. Review final TAB report, explaining the layout and meanings of each data type.
 - 2. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
 - 3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
 - 4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
 - 5. Other salient information that may be useful for facility operations, relative to TAB.
- F. HVAC Control System Training: Perform training in at least three phases:
 - 1. Phase 1 - Basic Control System: Provide minimum of ____ hours of actual training on the control system itself. Upon completion of training, each attendee, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
 - a. This training may be held on-site or at the manufacturer's facility.
 - b. If held off-site, the training may occur prior to final completion of the system installation.
 - c. For off-site training, Contractor shall pay expenses of up to two attendees.
 - 2. Phase 2 - Integrating with HVAC Systems: Provide minimum of ____ hours of on-site, hands-on training after completion of Functional Testing. Include instruction on:
 - a. The specific hardware configuration of installed systems in this facility and specific instruction for operating the installed system, including interfaces with other systems, if any.
 - b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control

- strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
- c. Trend logging and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends; provide practice in setting up trend logging and monitoring during training session.
 - d. Every display screen, allowing time for questions.
 - e. Point database entry and modifications.
3. Phase 3 - Post-Occupancy: Six months after occupancy conduct minimum of ____ hours of training. Tailor training session to questions and topics solicited beforehand from Government. Also be prepared to address topics brought up and answer questions concerning operation of the system.
- G. Provide the services of manufacturer representatives to assist instructors where necessary.
 - H. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

END OF SECTION

**SECTION 23 09 13
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Control panels.
- B. Damper Operators:
 - 1. Electric operators.
- C. Humidistats:
 - 1. Room humidistats.
 - 2. Limit duct humidistats.
- D. HVAC&R Sensors:
 - 1. Temperature sensors.
 - 2. Humidity sensors.
 - 3. Static pressure (air pressure) sensors.
 - 4. Current sensors.
 - 5. Damper position indicators.
- E. Thermostats:
 - 1. Electric room thermostats.
 - 2. Line voltage thermostats.
 - 3. Room thermostat accessories.
 - 4. Airstream thermostats.
 - 5. Electric low limit duct thermostats.
- F. Flow Sensors:
 - 1. Airflow measurement (AFMS).

1.02 RELATED REQUIREMENTS

- A. Section 23 09 23 - Direct-Digital Control System for HVAC.

1.03 REFERENCE STANDARDS

- A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.
- B. Modbus (PS) - The Modbus Organization Communications Protocol..
- C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- E. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
- C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
- D. Manufacturer's qualification statement.

- E. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
- F. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Government's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the Commonwealth of Pennsylvania.
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.07 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 EQUIPMENT - GENERAL

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.02 CONTROL PANELS

- A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.
- B. NEMA EN 10250, general purpose utility enclosures with enameled finished face panel.

2.03 DAMPERS

- A. Performance: Test in accordance with AMCA 500-D.
- B. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 12 gauge, 0.1046 inch.
- C. Blades: Galvanized steel, maximum blade size 8 inches wide, 48 inches long, minimum 22 gauge, 0.0299 inch, attached to minimum 1/2 inch shafts with set screws.
- D. Blade Seals: Synthetic elastomeric, inflatable, mechanically attached, field replaceable.
- E. Jamb Seals: Spring stainless steel.
- F. Linkage Bearings: Oil impregnated sintered bronze.
- G. Leakage: Less than one percent based on approach velocity of 2000 fpm and 4 in-wc.
- H. Maximum Pressure Differential: 6 in-wc.
- I. Temperature Limits: Minus 40 to 200 degrees F.

2.04 DAMPER OPERATORS

- A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
- B. Electric Operators:
 - 1. Manufacturers:
 - a. Belimo; www.belimo.com
 - b. Pottorff; www.pottorff.com
 - c. Honeywell; <https://www.honeywellbuildings.in/bms/field-devices/damper-actuators#>
 - 2. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.

2.05 HUMIDISTATS

- A. Room Humidistats:
 - 1. Wall mounted, proportioning type.
 - 2. Throttling Range: Adjustable 2 percent relative humidity.
 - 3. Operating Range: 30 to 80 percent.
 - 4. Maximum Temperature: 110 degrees F.
 - 5. Cover: Set point indication.
- B. Limit Duct Humidistats:
 - 1. Insertion, two position type.
 - 2. Throttling Range: Adjustable 2 percent relative humidity.
 - 3. Operating Range: 20 to 80 percent.
 - 4. Maximum Temperature: 150 degrees F.

2.06 HVAC&R SENSORS

- A. Temperature Sensors:
 - 1. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.
 - 2. Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F.
 - 3. 100 ohm platinum RTD is acceptable if used with project DDC controllers.
 - 4. Temperature Sensing Device: Compatible with project DDC controllers.
 - 5. Performance Characteristics:
 - a. RTD:
 - 1) Room Sensor Accuracy: Plus/minus 0.50 degrees F minimum.
 - 2) Duct Averaging Accuracy: Plus/minus 0.50 degrees F minimum.
 - 3) Chilled Water Accuracy: Plus/minus 0.50 degrees F minimum.
 - 4) All Other Accuracy: Plus/minus 0.75 degrees F minimum.
 - 5) Range: Minus 40 degrees F through 220 degrees F minimum.
 - b. Thermistor:
 - 1) Accuracy (All): Plus/minus 0.36 degrees F minimum.
 - 2) Range: Minus 25 degrees F through 122 degrees F minimum.
 - 3) Heat Dissipation Constant: 2.7 mW per degree C.
 - c. Temperature Transmitter:
 - 1) Accuracy: 0.10 degree F minimum or plus/minus 0.20 percent of span.
 - 2) Output: 4 to 20 mA.
 - d. Sensing Range:
 - 1) Provide limited range sensors if required to sense the range expected for a respective point.
 - 2) Use RTD type sensors for extended ranges beyond minus 30 to 230 degrees F.
 - 3) Use temperature transmitters in conjunction with RTD's when RTD's are incompatible with DDC controller direct temperature input.
 - e. Wire Resistance:
 - 1) Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.
 - 2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.
 - f. Room Sensors: Locking cover matching the pneumatic thermostats used.
 - g. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
 - h. Immersion Temperature Sensors: A sensor encased in a corrosion-resistant probe with an indoor junction box service entry body.
 - i. Ceiling and Recessed Mount Temperature Sensors: Ceiling-mounted sensor in a low-profile housing.

- j. Room Security Sensors: Stainless steel cover plate with insulated back and security screws.
- k. Room Temperature Sensors:
 - 1) Construct for surface or wall box mounting.
 - 2) Provide the following:
 - (a) Setpoint reset slide switch with an adjustable temperature range.
 - (b) Individual heating/cooling setpoint slide switches.
 - (c) Momentary override request push button for activation of after-hours operation.
 - (d) Analog thermometer.
- l. Room Temperature Sensors with Integral Digital Display:
 - 1) Construct for surface or wall box.
 - 2) Provide a four button keypad with the following capabilities:
 - (a) Indication of space and outdoor temperatures.
 - (b) Setpoint adjustment to accommodate room setpoint, DDC Input/Output Points List, and Sequence of Operation.
 - (c) Display and control fan operation status.
 - (d) Manual occupancy override and indication of occupancy status.
 - (e) Controller mode status.
 - (f) Password enabled setpoint and override modes.
- B. Humidity Sensors:
 - 1. Duct Mounted Sensor: Voltage type encased in a die-cast metal, weather-proof housing.
 - a. Input Power, Voltage Type: Class 2; 12-30 VDC/24 VAC, 15mA max.
- C. Damper Position Indicators: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 to 100 percent damper travel.

2.07 THERMOSTATS

- A. Line Voltage Thermostats:
 - 1. Dead Band: Maximum 2 degrees F.
 - 2. Cover: Locking with set point adjustment, with thermometer.
 - 3. Rating: Motor load.
- B. Room Thermostat Accessories:
 - 1. Thermostat Covers: Brushed aluminum.
 - 2. Insulating Bases: For thermostats located on exterior walls.
- C. Airstream Thermostats:
 - 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.
 - 2. Averaging service remote bulb element: 7.5 feet.
- D. Electric High/Low Limit Duct Thermostats:
 - 1. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is above, equal to, or below setpoint,
 - 2. Bulb length: Minimum 20 feet.
 - 3. Provide one thermostat for every 20 sq ft of coil surface.

2.08 FLOW SENSORS

- A. Airflow Measurement Station (AFMS):
 - 1. Airflow Straighteners:
 - a. Provide AFMS's with an airflow straightener if required by the AFMS manufacturer's published installation instructions.
 - b. In the absence of published documentation, provide airflow straighteners if there is any duct obstruction within 5 duct diameters upstream of the AFMS.

- c. Straightener: Contained inside a flanged sheet metal casing, with the AFMS located as specified according to the published recommendations of the AFMS manufacturer.
- 2. Outdoor Air Temperature: In outside air measurement or in low-temperature air delivery applications, provide an AFMS certified by the manufacturer to be accurate as specified over a temperature range of minus 20 to 120 degrees F.
- 3. Airflow Resistance:
 - a. Resistance to Airflow Through the AFMS and the Airflow Straightener: Not to exceed 0.085 in-wc at an airflow velocity of 2,000 fpm.
 - b. AFMS Construction: Suitable for operation at air flows of up to 5000 fpm over a temperature range of 40 to 120 degrees F.
- 4. Pitot Tube:
 - a. Furnish each pitot tube AFMS with an array of velocity sensing elements.
 - b. Velocity Sensing Elements: Multiple pitot tube type with averaging manifolds.
 - c. Distribute the sensing elements across the duct section in the pattern and quantity specified or as recommended by the installation instructions of the AMFS manufacturer.
 - 1) Pitot Tube AFMS's in Air Flows Over 600 fpm: Accuracy of plus/minus 5 percent over a range of 500 to 2,500 fpm.
 - 2) Pitot Tube AFMS's in Air Flows Under 600 fpm: Accuracy of plus/minus 5 percent over a range of 125 to 2,500 fpm.
- 5. Electronic:
 - a. Each electronic AFMS to consist of an array of velocity sensing elements of the resistance temperature detector (RTD) or thermistor type.
 - b. Sensing Elements: Distributed across the duct cross section in the quantity and pattern specified or recommended by the published application data of the manufacturer.
 - c. Electronic AFMS: Accuracy of plus/minus 5 percent over a range of 125 to 5,000 fpm and temperature compensated output over a range of 32 to 212 degrees F.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that systems are ready to receive work.
- B. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- C. Ensure installation of components is complementary to installation of similar components.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check and verify location of thermostats with plans and room details before installation. Locate 60 inches above floor. Align with lighting switches and humidistats; see Section 26 27 26.
- C. Provide conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

END OF SECTION

SECTION 23 09 23
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. System description.
- B. Operator interface.
- C. System software.
- D. Controller software.
- E. HVAC control programs.

1.02 RELATED REQUIREMENTS

- A. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
- B. Section 23 09 93 - Sequence of Operations for HVAC Controls.
- C. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks.
- B. NFPA 70 - National Electrical Code.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting at least one week prior to the start of the work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for each system component and software module.
- C. Shop Drawings:
 - 1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
 - 2. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.
 - 3. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 - 4. Indicate description and sequence of operation of operating, user, and application software.
- D. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
- E. Operation and Maintenance Data:
 - 1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
 - 2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
- F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Government's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.

1.07 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Provide five year manufacturer's warranty for field programmable micro-processor based units.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Honeywell International, Inc: www.honeywell.com/#sle.
- B. Or Approved Equal.

2.02 SYSTEM DESCRIPTION

- A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.
- B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
- C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 09 13.
- E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.03 OPERATOR INTERFACE

- A. PC Based Work Station:
- B. Workstation, controllers, and control backbone to communicate using BACnet protocol and addressing.
- C. BACnet protocol to comply with ASHRAE Std 135.
- D. Hardware:

2.04 CONTROLLERS

- A. Building Controllers:
 - 1. General:
 - a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
 - b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - c. Share data between networked controllers.
 - d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - e. Utilize real-time clock for scheduling.
 - f. Continuously check processor status and memory circuits for abnormal operation.
 - g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.

- h. Communication with other network devices to be based on assigned protocol.
 - 2. Communication:
 - a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
 - b. Perform routing when connected to a network of custom application and application specific controllers.
 - c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 - 4. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 - 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 - 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- B. Application Specific Controllers:
 - 1. General:
 - a. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
 - b. Customized for operation within the confines of equipment served.
 - c. Communication with other network devices to be based on assigned protocol.
 - 2. Communication:
 - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 - 4. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 - 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 - 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.

- c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.
- C. Input/Output Interface:
 - 1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
 - 2. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
 - b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
 - 3. Binary Inputs:
 - a. Allow monitoring of On/Off signals from remote devices.
 - b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
 - c. Sense dry contact closure with power provided only by the controller.
 - 4. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 10 pulses per second.
 - 5. Analog Inputs:
 - a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
 - b. Compatible with and field configurable to commonly available sensing devices.
 - 6. Binary Outputs:
 - a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
 - b. Outputs provided with three position (On/Off/Auto) override switches.
 - c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
 - 7. Analog Outputs:
 - a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
 - b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
 - c. Drift to not exceed 0.4 percent of range per year.
 - 8. Tri State Outputs:
 - a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
 - b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
 - c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
 - 9. System Object Capacity:
 - a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
 - b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.05 SYSTEM SOFTWARE

- A. Operating System:
 - 1. Concurrent, multi-tasking capability.
 - a. Common Software Applications Supported: Microsoft Excel.
 - 2. System Graphics:

- a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
 - b. Animation displayed by shifting image files based on object status.
 - c. Provide method for operator with password to perform the following:
 - 1) Move between, change size, and change location of graphic displays.
 - 2) Modify on-line.
 - 3) Add, delete, or change dynamic objects consisting of:
 - (a) Analog and binary values.
 - (b) Dynamic text.
 - (c) Static text.
 - (d) Animation files.
 3. Custom Graphics Generation Package:
 - a. Create, modify, and save graphic files and visio format graphics in PCX formats.
 - b. HTML graphics to support web browser compatible formats.
 - c. Capture or convert graphics from AutoCAD.
 4. Standard HVAC Graphics Library:
 - a. HVAC Equipment:
 - b. Ancillary Equipment:
- B. Workstation System Applications:
1. Automatic System Database Save and Restore Functions:
 - a. Current database copy of each Building Controller is automatically stored on hard disk.
 - b. Automatic update occurs upon change in any system panel.
 - c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
 2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
 - a. Save database from any system panel.
 - b. Clear a panel database.
 - c. Initiate a download of a specified database to any system panel.
 3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
 4. On-line Help:
 - a. Context-sensitive system assists operator in operation and editing.
 - b. Available for all applications.
 - c. Relevant screen data provided for particular screen display.
 - d. Additional help available via hypertext.
 5. Security:
 - a. Operator log-on requires user name and password to view, edit, add, or delete data.
 - b. System security selectable for each operator.
 - c. System supervisor sets passwords and security levels for all other operators.
 - d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
 - e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
 - f. All system security data stored in encrypted format.
 6. System Diagnostics:
 - a. Operations Automatically Monitored:
 - 1) Workstations.
 - 2) Printers.
 - 3) Modems.
 - 4) Network connections.

- 5) Building management panels.
 - 6) Controllers.
- b. Device failure is annunciated to the operator.
- 7. Alarm Processing:
 - a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
 - b. Configurable Objects:
 - 1) Alarm limits.
 - 2) Alarm limit differentials.
 - 3) States.
 - 4) Reactions for each object.
- 8. Alarm Messages:
 - a. Descriptor: English language.
 - b. Recognizable Features:
 - 1) Source.
 - 2) Location.
 - 3) Nature.
- 9. Configurable Alarm Reactions by Workstation and Time of Day:
 - a. Logging.
 - b. Printing.
 - c. Starting programs.
 - d. Displaying messages.
 - e. Dialing out to remote locations.
 - f. Paging.
 - g. Providing audible annunciation.
 - h. Displaying specific system graphics.
- 10. Custom Trend Logs:
 - a. Definable for any data object in the system including interval, start time, and stop time.
 - b. Trend Data:
 - 1) Sampled and stored on the building controller panel.
 - 2) Archivable on hard disk.
 - 3) Retrievable for use in reports, spreadsheets and standard database programs.
 - 4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
 - 5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.
- 11. Alarm and Event Log:
 - a. View all system alarms and change of states from any system location.
 - b. Events listed chronologically.
 - c. Operator with proper security acknowledges and clears alarms.
 - d. Alarms not cleared by operator are archived to the workstation hard disk.
- 12. Object, Property Status and Control:
 - a. Provide a method to view, edit if applicable, the status of any object and property in the system.
 - b. Status Available by the Following Methods:
 - 1) Menu.
 - 2) Graphics.
 - 3) Custom Programs.
- 13. Reports and Logs:
 - a. Reporting Package:
 - 1) Allows operator to select, modify, or create reports.
 - 2) Definable as to data content, format, interval, and date.
 - 3) Archivable to hard disk.

- b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
 - c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
 - d. Set to be printed on operator command or specific time(s).
14. Reports:
- a. Standard:
 - 1) Objects with current values.
 - 2) Current alarms not locked out.
 - 3) Disabled and overridden objects, points and SNVTs.
 - 4) Objects in manual or automatic alarm lockout.
 - 5) Objects in alarm lockout currently in alarm.
 - 6) Logs:
 - (a) Alarm History.
 - (b) System messages.
 - (c) System events.
 - (d) Trends.
 - b. Custom:
 - 1) Daily.
 - 2) Weekly.
 - 3) Monthly.
 - 4) Annual.
 - 5) Time and date stamped.
 - 6) Title.
 - 7) Facility name.
 - c. Tenant Override:
 - 1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
 - 2) Annual report showing override usage on a monthly basis.
 - d. Electrical, Fuel, and Weather:
 - 1) Electrical Meter(s):
 - (a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
 - (b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
 - 2) Fuel Meter(s):
 - (a) Monthly showing daily natural gas consumption for each meter.
 - (b) Annual summary showing monthly consumption for each meter.
 - 3) Weather:
 - (a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.
- C. Workstation Applications Editors:
- 1. Provide editing software for each system application at PC workstation.
 - 2. Downloaded application is executed at controller panel.
 - 3. Full screen editor for each application allows operator to view and change:
 - a. Configuration.
 - b. Name.
 - c. Control parameters.
 - d. Set-points.
 - 4. Scheduling:
 - a. Monthly calendar indicates schedules, holidays, and exceptions.
 - b. Allows several related objects to be scheduled and copied to other objects or dates.
 - c. Start and stop times adjustable from master schedule.
 - 5. Custom Application Programming:

- a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
- b. Programming Features:
 - 1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
 - 2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
 - 3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
 - 4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
 - 5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
 - 6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - 7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
 - 8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.
 - 9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.06 CONTROLLER SOFTWARE

- A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.
- B. System Security:
 - 1. User access secured via user passwords and user names.
 - 2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
 - 3. User Log On/Log Off attempts are recorded.
 - 4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
- C. Object or Object Group Scheduling:
 - 1. Weekly Schedules Based on Separate, Daily Schedules:
 - a. Include start, stop, optimal stop, and night economizer.
 - b. 10 events maximum per schedule.
 - c. Start/stop times adjustable for each group object.
- D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.
- E. Alarms:
 - 1. Binary object is set to alarm based on the operator specified state.
 - 2. Analog object to have high/low alarm limits.
 - 3. All alarming is capable of being automatically and manually disabled.
 - 4. Alarm Reporting:
 - a. Operator determines action to be taken for alarm event.
 - b. Alarms to be routed to appropriate workstation.
 - c. Reporting Options:
- F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.

- G. Sequencing: Application software based upon specified sequences of operations on Contract Drawings.
- H. PID Control Characteristics:
 - 1. Direct or reverse action.
 - 2. Anti-windup.
 - 3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
 - 4. User selectable controlled variable, set-point, and PED gains.
- I. Staggered Start Application:
 - 1. Prevents all controlled equipment from simultaneously restarting after power outage.
 - 2. Order of equipment startup is user selectable.
- J. Energy Calculations:
 - 1. Accumulated instantaneous power or flow rates are converted to energy use data.
 - 2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
 - 3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.
- K. Anti-Short Cycling:
 - 1. All binary output objects protected from short-cycling.
 - 2. Allows minimum on-time and off-time to be selected.
- L. On-Off Control with Differential:
 - 1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
 - 2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.
- M. Run-Time Totalization:
 - 1. Totalize run-times for all binary input objects.
 - 2. Provides operator with capability to assign high run-time alarm.

2.07 HVAC CONTROL PROGRAMS

- A. General:
 - 1. Support Inch-pounds and SI (metric) units of measurement.
 - 2. Identify each HVAC Control system.
- B. Optimal Run Time:
 - 1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
 - 2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
 - 3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
 - 4. Use outside air temperature to determine early shut down with ventilation override.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.02 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93.

- C. Provide conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.03 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate complete and operating system to Government.

3.04 MAINTENANCE

- A. Provide service and maintenance of energy management and control systems for one year from Date of Substantial Completion.
- B. Provide two complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.
- C. Provide complete service of systems, including call backs. Make minimum of 2 complete normal inspections of approximately 8 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

**SECTION 23 11 23
FACILITY NATURAL-GAS PIPING**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Pipe, pipe fittings, valves, and connections for natural gas piping systems.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.

1.03 REFERENCE STANDARDS

- A. ASME BPVC-IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators - Welding Brazing and Fusing Qualifications.
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
- C. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- D. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- E. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C. Welder Certificate: Include welders certification of compliance with ASME BPVC-IX.
- D. Shop Drawings: For non-penetrating rooftop supports, submit detailed layout developed for this project, with design calculations for loadings and spacings.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS**2.01 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING**

- A. Underground Piping, High Density Polyethylene Pipe (HDPE):
 - 1. Pipe: ASTM D2513, 100 psig working pressure, Standard Dimension Ratio (SDR), the ratio of pipe diameter to wall thickness, 11.5 maximum. Pipe to be manufactured from PE 4710 resin.
 - 2. Color: Solid yellow or black with yellow stripping for easy identification.
 - 3. Socket Fittings: ASTM D2683.
 - 4. Butt-Fusion Fittings: ASTM D2513. molded.
- B. Underground Piping Within Pipe Trench::
 - 1. Provide caution tape 6" - 12" below grade, per gas utility requirements.
 - 2. Provide wire within 6" from buried pipe (below or above), per gas utility requirements.
 - 3. Provide screening 6" above gas pipe.

2.02 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40 black steel.
 - 1. Less than 2 psi
 - a. Threaded Fittings: ASME B16.3, black malleable iron..
 - b. Unions: ASME B16.39, black malleable iron.
 - 2. Mechanical Press Sealed Fittings are prohibited.

2.03 RISERS - NATURAL GAS PIPING

- A. Manufacturer's standard riser, transition from plastic to steel pipe with 7 to 12 mills thick epoxy coating. Use swaged gas-tight construction with O-ring seals, metal insert, and protective sleeve.

2.04 TRANSITIONS FITTINGS

- A. Steel-to-plastic (HDPE): As specified in "risers-natural gas piping" except designed for steel-to-plastic with tapping tee or sleeve. Coat or wrap exposed steel piping with heavy plastic coating.
- B. Manufacturer's standard slip-on PE Mechanical coupling, molded, with stainless-steel ring support, O-ring seals, and rated for 150 psig gas service.

2.05 FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 3 Inches and Under:
- B. Dielectric connections are not allowed for natural gas piping.

2.06 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
 - 3. Trapeze Hangers: Welded steel channel frames attached to structure.
 - 4. Vertical Pipe Support: Steel riser clamp.

2.07 BALL VALVES, ABOVE GRADE PIPING

- A. Manufacturers:
 - 1. Apollo Valves: www.apollovalves.com/#sle.
 - 2. Grinnell Products: www.grinnell.com/#sle.
 - 3. Milwaukee Valve Company: www.milwaukeevalve.com/#sle.
 - 4. Nibco, Inc: www.nibco.com/#sle.
 - 5. Or Approved Equal.
- B. Ball Valve: Rated for natural gas.
- C. Material: Brass.
- D. Pressure Rating: 600 psi maximum.
- E. Temperature Rating: 200 Degrees F maximum.
- F. Stem Packing: PTFE or RPTFE.
- G. Ball Seat: PTFE or RPTFE..
- H. Handle: Stainless Steel.

2.08 PLUG VALVES, ABOVE GRADE PIPING

- A. Manufacturers:
 - 1. Apollo Valves: www.apollovalves.com/#sle.
 - 2. Grinnell Products: www.grinnell.com/#sle.
 - 3. Milwaukee Valve Company[<>]: www.milwaukeevalve.com/#sle.
 - 4. Nibco: www.nibco.com

- 5. Or Approved Equal.
- B. Plug Valve: Rated for natural gas service.

2.09 UNIONS, ABOVE GRADE PIPING

- A. Material
 - 1. Malleable iron, 150 psig working pressure.
 - 2. Connection: Threaded.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.
- C. Install valves with stems upright or horizontal, not inverted.
- D. Sleeve pipes passing through partitions, walls and floors.
- E. Paint exposed exterior and interior steel piping safety yellow with protective enamel paint.
- F. Stub PE piping minimum 4" above grade before transitioning to steel pipe above grade.

3.04 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- C. Provide plug valves in natural gas systems for shut-off service.

3.05 SERVICE CONNECTIONS

- A. Coordinate with local gas utility (UGI Utilities Inc), to for new gas service complete with gas meter and regulators and gas piping in accordance with local codes and regulations. Gas service distribution piping to have initial minimum pressure of 7 inch wg.. Trenching for gas piping installation, by Contractor. Piping from gas main to gas meter, furnished and installed by gas utility. Gas meter installation by gas utility.
- B. Gas piping and trenching from gas meter to building, shall be provided by Mechanical Contractor.

END OF SECTION

SECTION 23 21 13
HYDRONIC PIPING - (CONDENSATE)

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Equipment drains and overflows.
- B. Pipe hangers and supports.
- C. Unions, flanges, mechanical couplings, and dielectric connections.
- D. Section 23 05 53 - Identification for HVAC Piping and Equipment.
- E. Section 23 07 19 - HVAC Piping Insulation.

1.02 REFERENCE STANDARDS

- A. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- C. ASME B31.9 - Building Services Piping.
- D. ASTM B32 - Standard Specification for Solder Metal.
- E. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- F. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
- G. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
- H. AWWA C606 - Grooved and Shouldered Joints.
- I. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.03 SUBMITTALS

- A. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Provide manufacturers catalog information.
 - 3. Indicate valve data and ratings.
- B. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum 10 years of documented experience.
- B. Provide all fittings, valves, and specialties from a single manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS**2.01 CONDENSATE PIPING SYSTEM REQUIREMENTS**

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.

- B. Condensate Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
 - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - 2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
 - 3. Grooved mechanical joints for condensate piping may be used in accessible locations only.
 - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, mezzanine, and as approved by Contracting Officer or Contracting Officer's Representative.
 - b. Use rigid joints unless otherwise indicated.
 - c. Use gaskets of molded synthetic rubber with central cavity, pressure-responsive configuration, and complying with ASTM D2000, Grade 2CA615A15B44F17Z for circulating medium up to maximum 230 degrees F or Grade M3BA610A15B44Z for circulating medium up to maximum 200 degrees F.
 - 4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
 - 1. Where grooved joints are used in piping, provide grooved valve/equipment connections if available; if not available, provide flanged ends and grooved flange adapters.

2.02 EQUIPMENT DRAINS AND OVERFLOWS

- A. Manufacturers
 - 1. ProPress, by Viega: www.viega.us.
 - 2. Nibco: www.nibco.com
 - 3. Wheatland: www.wheatland.com
 - 4. Mueller Streamline Company; muellerstreamline.com
 - 5. Substitutions: Or Approved Equal.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type M (C), drawn; using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - 2. Grooved Mechanical Joints: Comply with ASTM F1476.

2.03 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 - 3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
 - 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 5. Vertical Support: Steel riser clamp.
 - 6. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 7. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 - 8. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
 - 9. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

- B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

2.04 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe 2 Inches and Less:
 - 1. Copper Pipe: Bronze, soldered joints.
- B. Mechanical Couplings for Grooved Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
 - 1. Dimensions and Testing: In accordance with AWWA C606.
 - 2. Mechanical Couplings: Comply with ASTM F1476.
 - 3. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 - 4. When pipe is field grooved, provide coupling manufacturer's grooving tools.
- C. Dielectric Connections:
 - 1. Waterways:
 - a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - b. Dry insulation barrier able to withstand 600-volt breakdown test.
 - c. Construct of galvanized steel with threaded end connections to match connecting piping.
 - d. Suitable for the required operating pressures and temperatures.
 - 2. Flanges:
 - a. Dielectric flanges with same pressure ratings as standard flanges.
 - b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - c. Dry insulation barrier able to withstand 600-volt breakdown test.
 - d. Construct of galvanized steel with threaded end connections to match connecting piping.
 - e. Suitable for the required operating pressures and temperatures.
 - 3. Unions:
 - a. 1/2 to 2 Inches: Brass solder to galvanized FPT.
 - b. Service: 250 psi, minus 20 to 180 deg F.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.
- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and to avoid interference with use of space.
- D. Group piping whenever practical at common elevations.
- E. Sleeve pipe passing through partitions, walls, and floors.
- F. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.

- G. Slope piping and arrange to drain at low points.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- I. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- K. Provide access where valves and fittings are not exposed.
- L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.

END OF SECTION

**SECTION 23 22 13
STEAM AND STEAM CONDENSATE PIPING**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Pipe and pipe fittings.
- B. Pipe hangers and supports.
- C. Steam piping system.
- D. Steam condensate piping system.

1.02 REFERENCE STANDARDS

- A. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- C. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- D. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
- E. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
- F. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.03 SYSTEM DESCRIPTION

- A. When more than one piping system material is selected, ensure systems components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.
- B. Use unions and flanges downstream of valves and at equipment or apparatus connections. Use dielectric unions where joining dissimilar materials. Do not use direct welded or threaded connections.

1.04 SUBMITTALS

- A. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- B. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labelling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS**2.01 LOW PRESSURE STEAM PIPING (15 PSIG MAXIMUM)**

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8M/A5.8 BCuP copper/silver alloy.
- B. Stainless Steel Tube: ASTM A312, Minimum DIN 1.4301

1. Joints: Straight bead welded.

2.02 LOW PRESSURE STEAM CONDENSATE PIPING

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn.
 1. Fittings: ASME B16.18, cast brass, or ASME B16.22, wrought copper.
 2. Joints: Braze, AWS A5.8M/A5.8 BCuP copper/silver alloy.

2.03 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring.
- C. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
- D. Vertical Support: Steel riser clamp.
- E. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- F. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- G. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.04 UNIONS, FLANGES, AND COUPLINGS

- A. Unions for Pipe 2 Inches and Under:
 1. Copper Pipe: Bronze, soldered joints.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems. See Section 23 25 00.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

END OF SECTION

**SECTION 23 23 00
REFRIGERANT PIPING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. VRF Refrigerant Piping.
- B. Refrigerant.
- C. Valves.
- D. Filter-driers.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 23 07 19 - HVAC Piping Insulation.

1.03 REFERENCE STANDARDS

- A. ASHRAE Std 15 - Safety Standard for Refrigeration Systems and Designation and Classification of Refrigerants.
- B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- C. ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
- D. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- E. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

1.04 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Piping to be triple evacuated during installation.
- C. Valves:
 - 1. Integral to mechanical unit
- D. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.
- E. Filter-Driers: By VRF Manufacturer.
- F. Solenoid Valves: By VRF manufacturer.

1.05 SUBMITTALS

- A. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.
- B. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- C. Test Reports: Indicate results of leak test, acid test.
- D. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
- E. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.
- F. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.
- G. Maintenance Materials: Furnish the following for Government's use in maintenance of project.

1. Extra Filter-Dryer Cartridges: One of each type and size.
2. Refrigeration Oil Test Kits: One, each containing everything required to conduct one test.

1.06 QUALITY ASSURANCE

- A. Designer Qualifications: Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties in shipping containers with labeling in place.
- B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Comply with ASME B31.9 for installation of piping system.

2.02 VRF REFRIGERANT PIPING

- A. Copper Tube: ASTM B280, H58 hard drawn. Air Conditioning Refrigeration (ACR) tubing.
 1. Cleaned, dehydrated, charged with nitrogen and capped.
 2. Pressure rating: 700 psi at 250 degrees F.
 3. Fittings: ASME B16.22 wrought copper.
 4. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.
- B. Never install driers, oil traps, sight glasses, shut-off valves, or any other line components in pipe work.
- C. The addition of isolation or stop valves and the specific manufacturer and type must be approved in writing by VRF/VRV manufacturer prior to installation.
- D. Expansion and contraction stress on Refnets, Headers, and equipment connections must be relieved through the use of expansion loops or offsets.
- E. Mechanical couplings for grooved joints not allowed for refrigerant piping.

2.03 REFRIGERANT

- A. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 700.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.02 VRF PIPING INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
 1. Only use tubing cutters. Never use a saw.
 2. Ream all cut tube ends to remove all burrs.
 3. Bleed nitrogen through tubing while soldering to prevent the formation of copper oxide scale within the tubing. Scale found within the system will void manufacturer's warranties.
 4. Use the proper brazing alloy (solder is not sufficient for 580 pound working pressure) when joining pipe: 15% silver Sil-Fos® 15 (no flux 1300°F).
 5. Use only VRF/VRV manufacturer-approved flare block to handle the higher pressures encountered with R410A. Use only synthetic oil on block so as not to contaminate the system.

6. Use only VRF/VRV manufacturer-approved torque wrenches on flared fittings and tighten fittings between the following range of torque.

<u>Flare Nut Size</u>	<u>Ft/lb torque</u>
1/4"	10.5 - 12.7
3/8"	24.2 - 29.4
1/2"	36.5 - 44.5
5/8"	45.6 - 55.6
3/4"	68.4 - 87.5

7. Close stop valves and pressure test piping with nitrogen and trace refrigerant as follows:

<u>Pressure (psig)</u>	<u>Duration (minutes)</u>
150	3
325	5
550	24

8. Triple evacuation is required as follows:

<u>Evacuate System to:</u>	<u>Procedure</u>
4,000 microns	Break vacuum with dry nitrogen to 2-3 psig for 15 minutes
1,500 microns	Maintain vacuum for 20 minutes
500 microns	Maintain vacuum for 60 minutes

9. Weigh in refrigerant with digital scale – or – utilize Auto Charge function if system is so equipped.
 10. Individually insulate all lines (suction, discharge, liquid) with closed cell insulation after pressure test and leak test.
 11. Carefully follow piping diagram in approved VRF/VRV submittal. Distances between components are critical. If a deviation is required due to job conditions consult your VRF/VRV representative before piping.
 12. Refnets and headers must be at least 40 inches from one another.
 13. 90° elbows must be at least 20 inches from Refnets, Headers, fan coils and Branch Selector boxes.
 14. Headers must be installed with branches in the horizontal plane or with branches pointing down.
 15. Refnets must be installed with both branches in the horizontal plane or with branches in the vertical position.
- B. Use fittings to make changes in direction in hard drawn and steel piping.
 - C. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
 - D. Install piping in concealed locations unless indicated otherwise. Piping above accessible ceilings shall be installed high enough to remove ceiling tiles.
 - E. Install piping to conserve building space and avoid interference with use of space.
 - F. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
 - G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
 - H. Install piping in conduit where exposed to damage.
 - I. Braze piping in accordance with the AWS brazing handbook.
 - J. Construct welded joints in accordance with AWS D10.12.
 - K. Slope hot gas piping downward away from the compressor.
 - L. Slope suction lines downward towards the compressor.

- M. Install sleeves and escutcheons where piping passes through walls and floors.
- N. Install piping at equipment to allow for regular maintenance access.
- O. Provide clearance for installation of insulation and access to valves and fittings.
- P. Insulate piping; see Section 23 07 16.
- Q. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
- R. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- S. Fully charge completed system with refrigerant after testing.
- T. Install refrigerant piping in accordance with ASHRAE 15 and Chapter 11 of the International Mechanical Code

3.03 FIELD QUALITY CONTROL

- A. Test refrigeration system in accordance with ASME B31.5.

3.04 SCHEDULES

- A. Refrigerant Piping
 - 1. Suction lines
 - a. 1-1/2" and smaller: Type ACR copper with brazed connections.
 - b. 4" and smaller: Type ACR drawn temper copper with brazed connections.
 - 2. Hot Gas and Liquid lines
 - a. 1-1/2" and smaller: Type ACR copper with brazed connections.
 - b. 4" and smaller: Type ACR drawn temper copper with brazed connections.

PART 4 MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. The work and material associated with this section shall be measured as a lump sum cost item.

4.02 PAYMENT

- A. The payment for the associated work and material associated with this section shall be as follows:
 - 1. ITEM NO: 232300
 - 2. DESCRIPTION: Refrigerant Piping
 - 3. PAY UNIT: Lump Sum

END OF SECTION

**SECTION 23 31 00
HVAC DUCTS AND CASINGS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Metal ductwork.
- B. Duct cleaning.

1.02 RELATED REQUIREMENTS

- A. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.
- B. Section 23 07 13 - Duct Insulation
- C. Section 23 33 00 - Air Duct Accessories.
- D. Section 23 37 00 - Air Outlets and Inlets.

1.03 REFERENCE STANDARDS

- A. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals.
- B. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

1.04 SUBMITTALS

- A. Product Data: Provide data for duct materials.
- B. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for pressure class indicated on Contract drawings.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.

PART 2 PRODUCTS**2.01 DUCT ASSEMBLIES**

- A. Ducts: Galvanized steel, unless otherwise indicated.
- B. Terminal Unit Low Pressure Supply and Return (System with Cooling Coils): See Contract Drawings.
- C. Air Handling Unit, Supply & Return Ductwork: See Contract Drawings.
- D. Dedicated Outside Air System, Supply & Exhaust Ductwork : See Contract Drawings.
- E. Exhaust fan, Exhaust Ductwork, See Contract Drawings.

2.02 GALVANIZED STEEL DUCT MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
- B. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - 1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - 2. VOC Content: Not more than 250 g/L, excluding water.
 - 3. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
- C. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.03 GALVANIZED STEEL DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.

- B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- D. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.
- E. The minimum thickness of the sheet metal shall be either as described in SMACNA's "HVAC Duct Construction Standard - Metal and Flexible" or as shown in the following table:
 1. Duct Construction Minimum Sheet Metal Gauges: Rectangular Ducts

RECTANGULAR DUCTS	
MAXIMUM SIDE (INCHES)	STEEL (MIN. GALVANIZED SHEET GAUGE)
THRU 12"	26 (0.022 INCHES)
13" - 30"	24 (0.028 INCHES)
31" - 54"	22 (0.034 INCHES)
55" - 84"	20 (0.040 INCHES)
OVER 84"	18 (0.052 INCHES)

2. Duct Construction Minimum Sheet Metal Gauges: Round Ducts

ROUND DUCT			
DIAMETER (INCHES)	SPIRAL SEAM DUCT STEEL (MIN. GALVANIZED SHEET GAUGE)	LONGITUDINAL SEAM DUCT STEEL (MIN. GALVANIZED SHEET GAUGE)	FITTINGS STEEL (MIN. GALVANIZED SHEET GAUGE)
THRU 12"	28 (0.019 IN.)	26 (0.022 IN.)	26 (0.022 IN.)
13" - 18"	26 (0.022 IN.)	24 (0.028 IN.)	24 (0.028 IN.)

- F. When required, heavier ductwork shall be installed to meet the requirements of the UL Fire Resistance Index.
- G. Rectangular Duct Section Connections- Shall be as described in the SMACNA Standards. Contractor may use zero leakage four corner bolted companion angle transverse joint as manufactured by DUCTMAKE INDUSTRIES. INC. or LOCKFORMER for lower pressure duct takeoffs. Joint shall be constructed of galvanized steel with bolting corner pieces, roll formed double wall mating angles, gasketing, mastic sealer and snap-on flange cover cleats.

2.04 STAINLESS STEEL DUCT MATERIALS

- A. Stainless steel, Construct of 18 gage, 0.0500 inch stainless steel, Stainless Steel for Ducts, Type 304..
- B. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.

2.05 DUCT ACCESS DOORS

- A. Duct Access Doors shall be provided in both the low and medium pressure duct systems as shown on the contract drawings and as specified.
- B. Access doors shall be constructed as shown in SMACNA standards for the appropriate pressure classification. Door shall be the same gauge and material as the duct. All access doors shall be hinged, except where a removable type is required.
- C. The minimum size of all access doors shall be 20" x 14" except where the duct is less than 16", in which case one dimension shall be 20" and the other 2" less than the duct width.

- D. Access doors shall be provided in the following locations: At the linkage side of automatic dampers; at the manual volume control dampers; at smoke detection heads; fire dampers; and any other service, balance or control device requiring periodic maintenance.

2.06 TURNING VANES

- A. Any square elbow ductwork 18 inches or over in width shall require turning vanes of galvanized steel.
- B. Vanes for Low and Medium Pressure Systems: Shall be as shown in SMACNA standards for appropriate pressure classification.
- C. Vane lengths shall not exceed 36" for low-pressure systems or 48" for medium pressure systems. Where greater lengths are required, separate banked sections shall be provided.

2.07 MANUFACTURED DUCTWORK AND FITTINGS

- A. Spiral Ducts: Round spiral lockseam duct with galvanized steel outer wall.
- B. Round Ducts: Round lockseam duct with galvanized steel outer wall.
 - 1. Manufacture in accordance with SMACNA (DCS).
- C. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).
- D. Round Duct Connection System: Interlocking duct connection system in accordance with SMACNA (DCS).

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Flexible Ducts: Connect to metal ducts with draw bands.
- C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- D. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- E. Connect diffusers or light troffer boots to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.
- F. Install stainless steel duct section, for humidifier section, as shown on Contract Drawings.

3.02 CLEANING

- A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment that could be harmed by excessive dirt with temporary filters, or bypass during cleaning.

END OF SECTION

**SECTION 23 33 00
AIR DUCT ACCESSORIES**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Backdraft dampers - metal.
- B. Duct access doors.
- C. Duct test holes.
- D. Fire dampers.
- E. Flexible duct connectors.
- F. Volume control dampers.
- G. Low leakage (Class 1A) control dampers.
- H. Electric Actuators
- I. Miscellaneous Products:
 - 1. Damper operators.
 - 2. Damper position switch.
 - 3. Duct opening closure film.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 23 31 00 - HVAC Ducts and Casings.
- C. Section 25 35 13 - Integrated Automation Actuators and Operators: Damper operators.
- D. Section 25 35 16 - Integrated Automation Sensors and Transmitters: Damper position switch.

1.03 REFERENCE STANDARDS

- A. NFPA 80 - Standard for Fire Doors and Other Opening Protectives.
- B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- C. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- E. UL 33 - Safety Heat Responsive Links for Fire-Protection Service.
- F. UL 555 - Standard for Fire Dampers.
- G. UL 555S - Standard for Smoke Dampers.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide for shop-fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.
- D. Manufacturer's Installation Instructions: Provide instructions for fire dampers.
- E. Project Record Drawings: Record actual locations of access doors and test holes.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS**2.01 BACKDRAFT DAMPERS - METAL**

- A. Manufacturers:
 - 1. Greenheck: www.greenheck.com/#sle.
 - 2. Louvers & Dampers, Inc, a brand of Mestek, Inc: www.louvers-dampers.com/#sle.
 - 3. Nailor Industries, Inc: www.nailor.com/#sle.
 - 4. Pottorff: www.pottorff.com/#sle.
 - 5. Ruskin Company: www.ruskin.com/#sle.
- B. Gravity Backdraft Dampers, Size 18 by 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.
- C. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.02 BACKDRAFT DAMPERS - GALVANIZED STEEL

- A. Backdraft Dampers: Factory-fabricated.
 - 1. Frame: Galvanized steel.
 - 2. Blades: Roll formed aluminum.
 - 3. Birdscreen: 1/2 inch nominal mesh of galvanized steel or aluminum.
 - 4. Maximum Velocity: 1000 fpm (5 mps) face velocity.

2.03 DUCT ACCESS DOORS

- A. Manufacturers:
 - 1. Ductmate Industries, Inc, a DMI Company: www.ductmate.com/#sle.
 - 2. Elgen Manufacturing Company, Inc: www.elgenmfg.com/#sle.
 - 3. Nailor Industries, Inc: www.nailor.com/#sle.
 - 4. Ruskin Company: www.ruskin.com/#sle.
- B. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick-fastening locking devices. For insulated ducts, install minimum 1-inch thick insulation with sheet metal cover.
 - 1. Less Than 12 inches Square: Secure with sash locks.
 - 2. Up to 18 inches Square: Provide two hinges and two sash locks.
 - 3. Up to 24 by 48 inches: Three hinges and two compression latches with outside and inside handles.

2.04 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.05 FIRE DAMPERS

- A. Manufacturers:
 - 1. Nailor Industries, Inc: www.nailor.com/#sle.
 - 2. NCA, a brand of Metal Industries Inc: www.ncamfg.com/#sle.
 - 3. Pottorff: www.pottorff.com/#sle.
 - 4. Ruskin Company: www.ruskin.com/#sle.
- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- C. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1-inch pressure-class ducts up to 12 inches in height.

- D. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.06 FLEXIBLE DUCT CONNECTORS

- A. Manufacturers:
1. Carlisle HVAC Products; Dynair Connector Plus G90 Steel Offset Seam Neoprene Fabric: www.carlislehvac.com/#sle.
 2. Ductmate Industries, Inc, a DMI Company: www.ductmate.com/#sle.
 3. Elgen Manufacturing Company, Inc: www.elgenmfg.com/#sle.
- B. UL 181, Class 1, aluminum laminate and polyester film with latex adhesive and supported by helically wound spring steel wire.
1. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
 2. Pressure Rating: 10 inches WG positive and 1.0 inch WG negative.
 3. Maximum Velocity: 4000 fpm.
 4. Temperature Range: Minus 20 degree F to 210 degrees F,
- C. Fabricate in accordance with SMACNA (DCS) and as indicated.

2.07 VOLUME CONTROL DAMPERS

- A. Manufacturers:
1. Elgen Manufacturing Company, Inc: www.elgenmfg.com/#sle.
 2. Nailor Industries, Inc: www.nailor.com/#sle.
 3. Pottorff: www.pottorff.com/#sle.
 4. Ruskin Company: www.ruskin.com/#sle.
 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Splitter Dampers:
1. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 2. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
- C. Multi-Blade Damper: Fabricate consisting of opposed blades with maximum blade sizes 8 by 72 inches. Assemble center- and edge-crimped blades in prime-coated or galvanized-channel frame with suitable hardware.
1. Blade: 18 gauge, 0.0478 inch, minimum.
- D. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.
- E. Quadrants:
1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

2.08 LOW LEAKAGE (CLASS 1A) CONTROL DAMPERS

- A. Manufacturers:
1. Ruskin Company; CD50: www.ruskin.com/#sle.
 2. United Enertech: www.unitedenertech.com/#sle.
 3. Pottorff[<>]: www.pottorff.com/#sle.
- B. Maximum Leakage Allowed: 3 cfm/sq ft at 1 in-wc.
- C. Frame:
1. Material: 20-gauge galvanized steel.
 2. Free-area: Single cross section.

3. Blanked-off: Split frame into two free-area sections to allow a smaller free-area to be used for a minimum airflow intake or exhaust application and secondary free-area fully blanked-off.
- D. Blade:
 1. Type: Multi-blade such as V or 3V for low to medium pressure.
 2. Operation: Opposed type.
 3. Maximum Individual Blade Height: 8 inches.
 4. Material: 12-gauge galvanized steel.
 5. Authority: Opposed type, 5 to 50 percent (typically 10 percent).

2.09 ELECTRIC ACTUATORS:

- A. Mechanical Configuration:
 1. On/Off or 2-Position:
 - a. Input: Line voltage from starter or VFD.
 - b.
 - c. Position Feedback: Dry contact.
 - d. Stroke Duration: 60 seconds, adjustable.
 - e. Fail Safe Control: Spring-return.
 2. Proportional (Modulated):
 - a. External Power: 24 VAC.
 - b. Position Feedback: 0 to 10 VDC.
 - c. Stroke Duration: 60 seconds.
 - d. Type: Maintenance-free brushless DC Motor.
 - e. Fail Safe Control: Built-in energy storage, return under 20 seconds.
 - f. Adjustable Settings: Stroke direction, zero, span, and offset.
- B. Enclosure Rating: Listed as complying with NEMA 250 and UL 50 or UL 50E use in non-hazardous locations such as:
 1. Indoors and Plenums: NEMA 250, Type 1.
 2. Mechanical Rooms: NEMA 250, Type 2, using any mounting orientation.
 3. Outdoors: NEMA 250, Type 4 or Type 4X with built-in heaters for extreme ambient conditions.

2.10 MISCELLANEOUS PRODUCTS

- A. Damper Operators: Provide manual and electric operators; see Section 25 35 13.
- B. Damper position switch; see Section 25 35 16.
- C. Duct Opening Closure Film: Mold-resistant, self-adhesive film to keep debris out of ducts during construction.
 1. Thickness: 2 mils.
 2. High tack water based adhesive.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). See Section 23 31 00 for duct construction and pressure class.
- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Provide duct access doors for inspection and cleaning before and after automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96 Provide minimum 8 by 8 inch size

access door for hand and shoulder access, or as indicated on drawings. Provide minimum 4 by 4 inch size access door for balancing dampers only. Review locations prior to fabrication.

- D. Provide duct test holes where indicated and required for testing and balancing purposes.
- E. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire-rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- F. Demonstrate re-setting of fire dampers to Government's representative.
- G. Use splitter dampers only where indicated.

END OF SECTION

**SECTION 23 34 16
CENTRIFUGAL HVAC FANS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Backward inclined centrifugal fans.
- B. Bearings and drives.
- C. Accessories.

1.02 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program.
- C. AMCA 99 - Standards Handbook.
- D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on centrifugal fans and accessories including fan curves with specified operating point plotted, power, rpm, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate assembly of centrifugal fans and accessories including fan curves with specified operating point plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- D. Manufacturer's Instructions: Include complete installation instructions.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors, shafts, and bearings from weather and construction dust.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. ACME Engineering and Manufacturing Corporation: www.acmefan.com/#sle.
- B. Carnes, a division of Carnes Company Inc; VIBK: www.carnes.com/#sle.
- C. Greenheck Fan Corporation; www.greenheck.com
- D. Loren Cook Company: www.lorencook.com/#sle.

2.02 PERFORMANCE REQUIREMENTS

- A. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300 and bearing AMCA Certified Sound Rating Seal.
- C. Fabrication: Comply with AMCA 99.
- D. UL Compliance: : UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- E. Electrical Components: : Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.03 WHEEL AND INLET

- A. Backward Inclined: Steel or aluminum construction with smooth curved inlet flange, heavy back plate, backwardly curved blades welded or riveted to flange and backplate; cast iron hub riveted to back plate and keyed to shaft with set screws.

2.04 HOUSING

- A. Heavy gauge steel, spot welded, adequately braced, designed to minimize turbulence with spun inlet bell and shaped cut.

2.05 BEARINGS AND DRIVES

- A. Bearings: Heavy duty pillow block type, self-greasing ball bearings, with ABMA STD 9 life at 50,000 hours.
- B. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil, and shaft guard.
- C. Drive: Drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.

2.06 ACCESSORIES

- A. Discharge Dampers: Parallel blade heavy-duty steel damper assembly with blades constructed of two plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever.
- B. Inlet/Outlet Screens: Galvanized steel welded grid.
- C. Disconnect Switch: Cord and plug in housing for thermal overload protected motor
- D. Roof Curb: Manufacturer's aluminum roof curb, 14" height, sized to meet fan opening requirements.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install flexible connections between fan inlet and discharge ductwork; see Section 23 33 00. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- C. Provide backdraft dampers on exhaust fans located at discharge side; see Section 23 33 00.

END OF SECTION

**SECTION 23 37 00
AIR OUTLETS AND INLETS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Diffusers:
 - 1. Rectangular ceiling diffusers.
 - 2. Louvered face ceiling diffusers.
- B. Registers/grilles:
 - 1. Ceiling supply grilles.
 - 2. Ceiling-mounted, egg crate exhaust and return grilles.
 - 3. Ceiling egg crate return grilles
 - 4. Ceiling & duct-mounted exhaust and return grilles.
 - 5. Ceiling-mounted, supply grilles.
 - 6. Ceiling filter return grilles.
- C. Duct-mounted supply and return registers/louvers.

1.02 REFERENCE STANDARDS

- A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating.
- B. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Air Inlets.

1.03 SUBMITTALS

- A. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

1.04 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
- B. Test and rate louver performance in accordance with AMCA 500-L.
- C. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Krueger-HVAC
- B. Price Industries
- C. Titus, a brand of Air Distribution Technologies

2.02 RECTANGULAR CEILING DIFFUSERS

- A. Type: Provide square, adjustable pattern, stamped, multi-core diffuser to discharge air in four way pattern.
- B. Connections: As indicated on drawings.
- C. Frame: Provide T-bar type. In plaster ceilings, provide plaster frame and ceiling frame.
- D. Fabrication: Steel with baked enamel finish. Provide with insulated back panel and vapor barrier extended past the neck of the air device connection.
- E. Color: White.

2.03 LOUVERED FACED CEILING DIFFUSERS

- A. Type: Fixed horizontal discharge pattern. These diffusers shall consist of an outer frame assembly of the sizes and mounting types shown on the plans and outlet schedule. A square or rectangular inlet shall be an integral part of the frame assembly and a transition piece shall be available to facilitate attachment of round duct. An inner core assembly consisting of fixed

deflection louvers shall be available in one-, two-, three- or four-way horizontal discharge patterns. The inner core assembly must be removable in the field without tools for easy installation, cleaning or damper adjustment.

- B. Connections: As indicated on drawings.
- C. Frame: Provide T-bar type. In plaster ceilings, provide plaster frame and ceiling frame.
- D. Fabrication: Steel with baked enamel finish.
- E. Color: White.

2.04 CEILING SUPPLY GRILLES

- A. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, two-way deflection.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
- C. Construction: Made of steel with factory enamel finish. Provide with insulated back panel and vapor barrier extended past the neck of the air device connection.
- D. Color: As selected by Contracting Officer or Contracting Officer's Representative from manufacturer's standard range.

2.05 CEILING & DUCT MOUNTED EXHAUST AND RETURN GRILLES

- A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, vertical face.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting.
- C. Fabrication: As indicated on contract drawings.
- D. Color: White.

2.06 CEILING FILTER RETURN GRILLES

- A. Type: Egg crate style face consisting of 1/2 by 1/2 by 1/2 inch grid core.
- B. Fabrication: Grid core consists of steel with baked enamel finish.
- C. Color: White.
- D. Frame: Channel lay-in frame for suspended grid ceilings.
- E. Accessories: Provide 1 inch filter frame.
- F. Furnish one set of 20"x20" MERV 8 filters for each filter grille for final installation, plus furnish one set of MERV 5 throwaway filters for each filter grille for use during construction.

2.07 WALL SUPPLY GRILLES

- A. Double-deflection supply grille. The deflection blades shall be available parallel to the long dimension of the grille or register. Blades shall be spaced on 3/4-inch centers.
 - 1. Sizes 24 x 24 inches and below shall have roll-formed borders with a minimum thickness of 0.032 inch.
 - 2. Screw holes shall be countersunk for a neat appearance. Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data.
 - 3. Blades shall have friction pivots on both sides to allow individual blade adjustment without loosening or rattling or be inserted through the frame and held tight with steel friction wire interlocked to the frame on both ends of each side. Plastic blade pivots are not acceptable.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
- C. Color: White.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

- B. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
- C. Install diffusers to ductwork with air tight connection.
- D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

END OF SECTION

**SECTION 23 74 33
DEDICATED OUTDOOR AIR UNITS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Roof-mounted DOAS.

1.02 RELATED REQUIREMENTS

- A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- B. Section 23 09 23 - Direct-Digital Control System for HVAC.

1.03 REFERENCE STANDARDS

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- B. AHRI 270 (SI/I-P) - Sound Performance Rating of Outdoor Unitary Equipment.
- C. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. NFPA 70 - National Electrical Code.
- E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- F. UL (DIR) - Online Certifications Directory.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data with dimensions, duct and service connections, accessories, controls, electrical nameplate data, and wiring diagrams.
- C. Shop Drawings: Indicate dimensions, duct and service connections, accessories, controls, electrical nameplate data, and wiring diagrams.
- D. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
- E. Operation And Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- F. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Government's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Provide five year manufacturers warranty for compressor/condenser unit.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. AAON; www.aaon.com/#sle
- B. CaptiveAire; www.captiveaire.com/#sle
- C. Daikin; www.daikin.com/products/ac/#sle/
- D. Greenheck; greenheck.com/products/air-conditioning/#sle
- E. Trane; trane.com/commercial/north-america/us/en/html
- F. Desert Aire; www.desert-aire.com/#sle.
- G. Or Approved Equal.

2.02 ROOF-MOUNTED DOAS PERFORMANCE REQUIREMENTS

- A. Performance Ratings: ASHRAE Std 90.1, EER and COP as applicable.
- B. Regulatory Requirements: AHRI 270 (SI/I-P) rated, NFPA 70, and UL (DIR) listed.
- C. Cabinet
 - 1. Unit shall be constructed of minimum 20 gauge G-90 galvanized steel riveted together via structural pop-rivets. All metal shall be CNC bent for precise assembly. All metal shall be CNC bent for precise assembly..
 - 2. Roof Construction: The lids shall be fabricated by forming a double-standing, self-locking seam that requires no additional support. Roof shall be pitched to allow for proper drainage.
 - 3. Exterior Wall Construction: All exterior walls shall consist of a double wall, G-90 galvanized steel construction. Cabinet shall be insulated with 2 in. thick, R13 closed cell foam.
 - 4. Service Access Doors: All door jambs shall be gasketed around their perimeter, and allow for doors to be mounted via removable, spring actuated, stainless steel hinges with stainless steel rivets, and self- compressing latches. Each compartment shall have removable access panels to allow for ease of service and maintainability. Electrical cabinet access doors shall have a door hold installed to prop doors open. All doors shall have stainless steel latches which are pad lockable. Electrical cabinet doors shall be outfitted with schematic/manual pouches formed into the door, along with wiring diagram attached to the indoor of the door from the factory.
- D. Entire interior and exterior casing shall be constructed of minimum G90 galvanized steel. The unit casing will not be painted. Unit shall have undergone a salt spray corrosion test as per ASTM B 117.
- E. Supply Air Blower and Motor
 - 1. All supply fan shall be direct drive (belt-drive not acceptable) variable speed plenum fans.
 - 2. Blower Motor: Motor shall be a premium efficiency motor available as: Electronically Commutated Motor (ECM). Alternatively, supply fan with manufacturer provided VFD is also acceptable.
 - 3. Fans to be selected at or near efficiency peak. (Submit fan curves)
 - 4. Blower and motor assembly shall be dynamically balanced. The entire blower and motor assembly shall be mounted on rubber vibration isolators. Wheels balanced as per AMCA 204-96, Balance Quality and Vibration Levels for fans.
 - 5. Unit equipped with total CFM monitoring to measure airflow across supply discharge.
- F. Refrigeration System
 - 1. Unit shall utilize a variable speed inverter duty scroll compressor with the following features:
 - a. Refrigerant: Unit shall be factory charged with R454B refrigerant.
 - b. Vibration Isolation: Compressor as well as blower assembly shall each be mounted on rubber vibration isolators to reduce transmission of vibration to the building structure.
 - c. Internal Overload Protection: Compressor shall include internal thermal overload protection to protect against excessive motor temperatures.
 - d. Crankcase Heater: Compressor shall include a crankcase heater to protect against liquid flood-back and elimination of oil foaming on startup. The crankcase heater must remain powered when the compressor is not in operation.
 - e. Oil Management: Unit shall utilize both passive and active oil return management using Oil Level Sensor and scheduled oil boosts.
 - f. Monitored Envelope: Unit shall monitor all critical refrigeration points to ensure compressor does not operate outside of safe operating envelope.
 - g. Throttling Logic: Unit shall allow for high head pressure monitoring throttle mode for high ambient operation, and low suction pressure throttle mode for low capacity operation or any conditions resulting in low suction pressure.

- h. Pump-Down: Active pump-down mode with discharge line check valve to protect against liquid migration into compressor during idle times.
 - i. Defrost mode in optional Heat Pump: When outdoor coils are deemed at risk of freezing, the unit shall simultaneously turn on auxiliary heat while running the heat pump in "cooling" mode to help defrost outdoor coils as needed while still maintain desired leaving air temperatures.
2. The unit shall be outfitted with the following:
- a. Indoor Coil: Indoor coil shall be a high efficiency 5 row coil design with aluminum fins mechanically bonded to copper tubes. Coil is staggered to increase turbulence, reduce the coil bypass factor, and ultimately increase the time the air stays within the coil. Includes two probe sensors to read average coil face temperature.
 - b. Electronic Expansion Valve: Each refrigeration circuit will be outfitted with an electronic expansion valve metering device which can be throttled from 0-100% open to allow for precise superheat control.
 - c. Indoor Coil Drain Pan: The indoor coil shall be outfitted with a sloped stainless steel drain pan. This pan shall be insulated along the entire base to prevent condensation, and outfitted with a safety overflow switch which will automatically shut down cooling operation prior to water overflowing the drain pan in the event of a drain clog. The entire drain pan shall be 20 GA Stainless Steel construction and wrap beneath the entire coil with flashing on entering side of coil to ensure capture of all condensate. Drain pan discharge pipe shall also be stainless steel construction. Drain pan shall be pitched to exceed ASHRAE 62.1 standard.
 - d. Base of the condensing coil cabinet shall be pitched away from the unit as a safety to ensure all draining exits away from the curb.
 - e. Optional Hot Gas Reheat Coil: The unit shall include an optional copper tube and aluminum fin hot gas reheat coil mounted downstream of the indoor coil. This coil shall be controlled via fully modulating hot gas reheat valve to provide precise reheat temperature control. This coil shall include the addition of an evaporative coil leaving condition sensor to maintain a coil dew point. This also prevents operation of a dehumidification call when intake dew point conditions are found to be below space dew point conditions, preventing wasted energy.
 - f. Outdoor (Condenser) Coil: Outdoor coil shall be a high efficiency coil design with aluminum fins mechanically bonded to copper tubes. The coil shall be downward sloped to protect coil from hail damage.
 - g. Outdoor Fans: The outdoor coil shall have a vertical discharge outfitted with quiet, efficient, fully modulating Electronically Commutated Motor (ECM) condensing fans. These fans shall modulate to maintain a temperature differential between outside air and the outdoor coil.
3. To help mitigate any long-term potential for leaks or hardware failures, the unit shall be outfitted with the following protection measures:
- a. Suction line accumulator for added protection against liquid entering suction line of compressor.
 - b. Bi-flow, low pressure drop, filter drier.
 - c. Electronic Expansion Valve (EEV) for precise superheat control. EEV shall open partially allowing system pressure equalization prior to activation of the compressor..
 - d. Heat pump unit, use of a single 3-way reheat valve to prevent obstructions due to valve failure.
 - e. Protective rubber sleeves installed on all distribution lines of indoor coil to prevent wear from rubbing.
 - f. All refrigeration ports shall be short-stub assembly and any access port with a transducer or switch is mounted vertically to mitigate risk of bent/cracked stub joints.
 - g. Refrigeration circuit shall be mechanically CNC pre-bent tubing wherever possible with minimal brazed joints to minimize points for potential refrigeration leaks.
 - h. Factory tested for leaks via high pressure nitrogen decay and helium tracer gas testing.

- i. Suction line temperature sensor failure detection.

G. Heating System

1. The gas burner shall be an indirect-fired, push-through type, using natural gas or liquid propane gas. The inlet-supply pressure to the unit for natural gas must be 7" w.c. minimum.
2. Burner shall be a tubular in-shot fired design capable of using natural gas. Each burner ignition shall be of the direct-spark design with remote flame sensing at inlet of the last firing tube of the gas manifold.
3. Direct-sparking sequence shall last through the complete duration of the trial for ignition period for guaranteed light-off. Burner shall always be lit at maximum gas flow and combustion airflow for guaranteed light-off. Each burner ignition module shall have LED indicators for troubleshooting and a set of exposed prongs for testing flame indication signal.
4. All furnaces shall be controlled by an electronic Vernier-type fully modulating control system capable of achieving 80% combustion efficiency over the entire gas firing range of the unit.
5. Each furnace shall have:
 - a. A minimum turndown ratio of 12:1 for natural gas while maintaining a constant 80% efficiency (90% for high efficiency furnace option). No cold air bypass of the heat exchanger.
 - b. Each furnace heat exchanger shall be a bent-tube style design made entirely of stainless steel.
 - c. Stainless steel Quick Seal Connection for gas connection.
 - d. Manifold and Input gas pressure gauges.
 - e. Factory piped condensate drain to exterior of cabinet.
 - f. A combustion flue to be installed on adjacent side as combustion intake with integrated high velocity wind cap.
 - g. A blocked vent safety airflow switch with high temperature silicone tubing operating off of absolute pressure measured inside of the power-vent blower housing.
 - h. A high temperature auto-recycling limit with a maximum non-adjustable set point.
 - i. A manual reset high temperature flame rollout switch with a non-adjustable set point.
 - j. Each furnace compartment shall have a removable post and panel that allows the furnace to be easily removed for service and maintainability.
 - k. A power-vent assembly for exhausting flue gases with a PSC or ECM type motor that is securely mounted and easily accessible/removable for service.
 - l. A 0-10" w.c. gas pressure gauge installed on the gas manifold.

H. Energy Recovery Wheel

1. Unit shall utilize a variable speed polymer energy recovery wheel with the following features:
 - a. Modulation: ERV wheel motor shall be capable of speed modulation that correlates to 16-60 rpm on all size ERV wheels.
 - b. Self Cleaning: Opposing airflows draw debris off both sides of the wheel. Time or manually activated cleaning cycles are available for times the ERV sits idle.
 - c. Defrost Cycles: If outdoor and return conditions present a risk of freezing, the energy wheel shall slow down to decrease energy transfer and defrost the wheel.
 - d. Internal Overload Protection: Energy recovery wheel drive motor shall include internal thermal overload protection to protect against excessive motor temperatures.
 - e. Initial Stage: Energy recovery wheel shall start as the first stage of heating or cooling before the unit starts to minimize energy consumption.
 - f. Segmented Media: Energy wheel is constructed of individual segmented media sections, allowing for replacement of single individual sections rather than the entire wheel in the event of maintenance or repair needs.

- g. Media Construction: Media is constructed of a lightweight polymer, which is permanently bonded with a silica gel desiccant for both sensible and latent heat recovery.
 - h. Purge Segment: Wheel is outfitted with an adjustable purge segment to minimize Exhaust Air Transfer Ratio (EATR).
 - i. Motor: Wheel driven by a belt drive motor with motor speed controls to allow for wheel speed modulation.
 - 2. To help mitigate any long-term potential for hardware failures, the unit shall be outfitted with the following protection measures:
 - a. Energy Wheel Malfunction Detection, if the ERV detects lack of energy transfer in the presence of a scenario with a large transfer potential the unit will report an error and trigger unit activation.
 - b. Clogged Filter and Energy Wheel monitoring, ERV will report high static pressures if present on the energy wheel or filter to indicate the need for servicing.
 - c. Missing Filter monitoring, ERV will report low static pressures if present in the filter banks to indicate the need for servicing.
- I. Filters
 - 1. Provide filters as part of unit. All filters shall be furnished and installed to meet the performance requirements set forth in the schedule and as specified under another section of this work.
 - 2. All filters shall be installed on tracks for easy removal from the unit.
 - 3. Up to 3 layers of outdoor air filtration installed. Unit shall ship with a 2" washable metal mesh outdoor air filter. Mixed air shall have optional 2" MERV-13 filters.
 - 4. Unit shall have an optional adjustable pressure differential sensor for the filter bank to alert in the event of a clogged filter.
- J. Electrical
 - 1. All controls shall be pre-wired and housed in an insulated electrical cabinet within the unit to protect against risk of condensation.
 - 2. Fan #1: Units shall be provided with single point electrical connection.
 - 3. Unit shall be provided with a door safety switch that de-energizes the supply fan when the door is opened.
 - 4. Unit shall be provided with a factory mounted averaging supply air temperature sensor to allow for accurate discharge temperature readings within unit when a downstream sensor is not installed. Field mounted and wired discharge air sensors will not be accepted.
 - 5. Unit shall be provided with a factory mounted averaging intake air temperature sensor to allow for accurate intake temperature reading regardless of how the OA/RA dampers are positioned.
 - 6. The electrical cabinet shall be outfitted with the following:
 - a. Disconnect for power to fully de-energize the electrical cabinet.
 - b. LED electrical cabinet service light with automatic activation upon door switch.
 - c. Color wiring schematics, laminated to the interior wall of the cabinet doors.
 - d. Factory mounted disconnect with unit bottom knockouts.
 - e. A LED backlit, LCD Human-Machine Interface (HMI) shall be mounted within the unit's control cabinet to allow for all set points configuration and refrigeration system monitoring at the unit.
 - 7. All sensors shall be wired back to the main control board that continuously monitors all critical components and makes decisions based on pre-determined logic to accurately control the following:
 - a. PID logic to control heater modulation ensuring precise discharge/space temperature control.
 - b. PID logic to control compressor speed to provide precise control over evaporative coil temperatures, leaving dew point, and discharge/space temperatures.
 - c. PID logic for Outdoor fan modulation to maintain an optimal outdoor coil temperature.

- d. PID logic for Electronic Expansion Valve (EEV) position to maintain a precise superheat temperature.
 - e. PID logic for Modulating Reheat valve to limit supply air temperature and relative humidity based off of space or discharge conditions.
- K. Controls
- 1. Unit shall be outfitted with a control board to allow for full control of the entire unit.
 - 2. Provide air flow switch on the supply fan system to sense air flow with available set of contacts for connection to BMS for airflow alerts.
 - 3. All unit controls shall be compatible with BACnet based building management systems.
 - 4. Exhaust Fan Control System.
 - a. . Manual Control: Unit locks the exhaust fan speed to accurately maintain the desired set point.
 - 5. Temperature Control System
 - a. Low-Ambient Cooling: Fan #1: Unit is factory outfitted with logic allowing for low-ambient operation of the DX system down to 0°F outdoor temperatures purely through software utilizing the standard factory modulating components.
 - b. Discharge Temp Control (Heating): Unit modulates the burner flame (current supply in the case of electric heating) to accurately maintain the desired discharge temperature set point and compensate for fluctuations in entering air temperature, air volume and % of OA using heating PID controls designed specifically for the unit.
 - 1) For ERV models, the unit will first modulate the energy recovery wheel to accurately maintain the desired discharge temperature set point, then lock into max speed once the burner is required to maintain desired discharge set point.
 - 6. Discharge Temp Control (Cooling): Unit modulates the compressor frequency to accurately maintain the desired discharge temperature set point and compensate for fluctuations in entering air temperature, air volume and % of OA using proprietary cooling PID controls designed specifically for the unit..
 - a. For ERV models, the unit will first modulate the energy recovery wheel to accurately maintain the desired discharge temperature set point, then lock into max speed once the compressor is required to maintain desired discharge set point.
 - 7. Discharge Temp Control (Heat Pump):
 - a. Fan: Unit modulates the compressor frequency to accurately maintain the desired discharge temperature set point and compensate for fluctuations in entering air temperature, air volume and % of OA using heating PID controls designed specifically for the unit. Minimum and maximum discharge set points can be set to limit the temperature entering the space. When ambient temperatures drop below a user configurable minimum outdoor air temperature set point, or the unit is not able to maintain a user configurable minimum discharge temp for 5 minutes time, the heat pump will initiate its backup heat source. Initiation of backup heater operation shall ensure discharge temps are maintained prior to disabling heat pump to make sure discharge temps are never impacted during changeover. An optional additional HMI or room thermostat can be used to determine the space temperature. In the case that no temperature sensor is available in the space, the unit will use an internal return temperature sensor.
 - 8. Discharge Humidity Control (Dehumidification):
 - a. Fan: Unit modulates the compressor frequency to accurately maintain a desired evaporative coil dew point measured via a coil mounted temperature sensor between the evaporative and hot gas reheat coils. A fully modulating hot gas reheat valve shall utilize excess waste heat from the condensing section feeding the hot gas reheat coil with the precise amount of heat needed to accurately reheat the airstream in order to maintain a desired discharge temperature compensating for fluctuations in entering air temperature, air volume and % of OA using proprietary dehumidification PID controls designed specifically for the unit.

- b. For ERV models, the unit will first modulate the energy recovery wheel to accurately maintain the desired space temperature set point, then lock into max speed once the burner is required to maintain desired discharge set point.
 - c. For ERV models, the unit will first modulate the energy recovery wheel to accurately maintain the desired space temperature set point, then lock into max speed once the compressor is required to maintain desired discharge set point.
- 9. Advanced Total Unit Economizer: The control system is outfitted standard, , without need for any additional hardware, with an Advanced Total Unit Economizer which will take maximum advantage of as much energy available in the outdoor air conditions in order to run the compressor the minimum amount required at any given incoming air conditions. If the outdoor enthalpy (temperature and relative humidity) permits, the unit will be capable of completely modulating and shutting off compressor to provide “free” cooling and dehumidification as the outdoor air conditions allow.
- 10. Activation Controls:
 - a. Activate Based on Sensible Difference (Heating): Unit will activate energy wheel when the outdoor air temperature is below the return air temperature and the unit is calling for heating.
 - b. Activate Based on Sensible Difference (Cooling): Unit will activate energy wheel when the outdoor air temperature is above the return air temperature and the unit is calling for cooling.
 - c. Activate Based on Enthalpy Difference (Heating): Unit will activate energy wheel when the outdoor air calculated enthalpy is below the return air calculated enthalpy and the Unit is calling for heating.
 - d. Activate Based on Enthalpy Difference (Cooling): Unit will activate energy wheel when the outdoor air calculated enthalpy is above the return air calculated enthalpy and the Unit is calling for cooling.
 - e. Activate Based on Both (Heating): Unit will activate energy wheel when the outdoor air temperature and calculated enthalpy is below the return air temperature and calculated enthalpy and the Unit is calling for heating.
 - f. Activate Based on Both (Cooling): Unit will activate energy wheel when the outdoor air temperature and calculated enthalpy is above the return air temperature and calculated enthalpy and the unit is calling for cooling.
- L. Roof Curb
 - 1. Unit shall be factory assembled, and constructed of 18 ga. galvanized steel.
 - 2. Curb shall be fully insulated with 1” acoustical and thermal insulation.
 - 3. Curb shall be factory outfitted with duct support hangers.
- M. Outside-Supply Fan Section: See Contract drawings.
- N. Return-Exhaust Fan Section: See Contract drawings.
- O. Packaged DX Cooling Section: See Contract drawings.
 - 1. Condenser Ambient Air Temperature: 95 degrees F.
- P. Energy Recovery Section: See Contract drawings.
- Q. Hot Gas Reheat Section: See Contract drawings.
- R. Electrical: 460 V, 3-phase, 60 Hz, single point to factory-mounted fused disconnect switch internally wired into motors and compressors, and other powered components including system safeties.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Adjusting: Use plenum static pressure readings against manufacturer calibration chart to adjust primary airflow as other measuring methods will not work.

- C. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 25 15 00.

3.02 CONNECTIONS

- A. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts.
- B. Electrical: Conform to applicable requirements in Division 26 Sections.
- C. Provide unit- or duct-mounted smoke detectors and other NFPA 90A provisions.
- D. Connect drain pan outlet to nearest building drain system piping.

3.03 SYSTEM START-UP

- A. System start up is performed by a factory trained Service Technician.

END OF SECTION

SECTION 23 81 26.13
SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Ductless Split System, Air cooled condensing units.
- B. Ductless Split System, Indoor evaporator (fan and coil) units for ductless systems.
- C. Controls.

1.02 REFERENCE STANDARDS

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- B. AHRI 520 - Performance Rating of Positive Displacement Condensing Units.
- C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems and Designation and Classification of Refrigerants.
- D. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical.

1.03 SUBMITTALS

- A. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- B. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.
- C. Warranty: Submit manufacturers limited 5-year or 10-year warranty and ensure forms have been filled out in Government's name and registered with manufacturer within 90 days o.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.05 WARRANTY

- A. Provide manufacturer's standard 5-year or 10-year warranty on parts.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Carrier Corporation: www.carrier.com/#sle.
- B. Trane Technologies, PLC: www.trane.com/#sle.
- C. Daikin AC; daikin.com/products/#sle.
- D. York International Corporation/Johnson Controls, Inc: www.york.com/#sle.

2.02 SYSTEM DESIGN

- A. Split-System Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
 - 1. Cooling: Outdoor electric condensing unit with evaporator coil in ductless indoor unit ("mini-split").
 - 2. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.
- B. Performance Requirements: See Drawings for additional requirements.
- C. Provide manufacturer's refrigerant leak detection system.
- D. Refrigerant: Refrigerant to have global warming potential of less than 700.
- E. Electrical Characteristics:
 - 1. 208 volts, single phase, 60 Hz.

2. See Contract Drawings for additional electrical requirements.

2.03 INDOOR AIR HANDLING UNITS FOR DUCTLESS SYSTEMS

- A. Indoor Units: Packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection to outdoor condensing unit or heat pump. Unit to have manufacturer's condensate overflow switch option.
- B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
 1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
 2. Manufacturer: System manufacturer.

2.04 OUTDOOR UNITS

- A. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.
- B. Compressor: Twin rotary type.
- C. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 700.
- D. Operating Controls:
 1. Control by room thermostat to maintain room temperature setting.

2.05 ACCESSORY EQUIPMENT

- A. Low-ambient kit / baffles.

2.06 CONTROLS

- A. Room Thermostat: Wired wall-mounted, electric solid state microcomputer based room thermostat with remote sensor to maintain temperature setting; low-voltage; with following features:
 1. Automatic switching from heating to cooling.
 2. Preferential rate control to minimize overshoot and deviation from setpoint.
 3. Thermostat Display:
 - a. Actual room temperature.
 - b. System Mode Indication: Cooling, Auto or On, Off.
- B. Room Temperature Sensor: Wired room temperature sensors, as part of building automatic system to monitor room temperature. Building automation system to provide a high temperature alarm in event room temperature rises 10 F (adj) above setpoint temperature in cooling mode.
- C. Condensate Overflow Switch: Provide manufacturer's condensate overflow switch accessory in primary drain pan or clipped to coils above the primary drain pan.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.
- B. Verify that proper power supply is available and in correct location.
- C. Verify that proper fuel supply is available for connection.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.
- B. Install refrigeration systems in accordance with ASHRAE Std 15.

END OF SECTION

SECTION 23 81 29
VARIABLE REFRIGERANT FLOW HVAC SYSTEMS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Branch selector boxes
- B. Air-source outdoor units - Heat Recovery Units
- C. Refrigerant piping.
- D. Refrigerant branch units.
- E. Indoor units.

1.02 REFERENCE STANDARDS

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- B. AHRI 1230 - Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment.
- C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
- D. ITS (DIR) - Directory of Listed Products.
- E. NFPA 70 - National Electrical Code.
- F. UL 1995 - Heating and Cooling Equipment.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Pre-Bid Submittals: For proposed substitute systems/products, as defined in PART 2, and alternate systems/products, as defined above, proposer shall submit all data described in this article, under the terms given for substitutions stated in PART 2.
- C. Product Data: Submit manufacturer's standard data sheets showing the following for each item of equipment, marked to correlate to equipment item markings indicated in Contract Documents:
 - 1. Outdoor Units:
 - a. Refrigerant Type and Size of Charge.
 - b. Output and Input Cooling Capacity: Btu/h.
 - c. Output and Input Heating Capacity: Btu/h.
 - d. Operating Temperature Range, Cooling and Heating.
 - e. Fan Capacity: Flow in cfm with respective fan curves.
 - f. External Static Pressure (ESP): In-wc.
 - g. Sound Pressure Level: dB(A).
 - h. Electrical Data: Complete including motor size.
 - i. Maximum number of indoor units that can be served.
 - j. Maximum refrigerant piping run from outdoor unit to indoor unit(s).
 - k. Maximum height difference between outdoor unit to Indoor unit(s), both above and below.
 - 2. Indoor Units:
 - a. Output and Input Cooling Capacity: Btu/h.
 - b. Output and Input Heating Capacity: Btu/h.
 - c. Fan Capacity: Flow in cfm with respective fan curves.
 - d. External Static Pressure (ESP): In-wc.
 - e. Electrical Data: Complete including motor size.
 - f. Maximum Lift of Built-in Condensate Pump.
 - 3. Control Panels: Complete data of controllers, input-output points, and zones.

- D. Shop Drawings: Installation drawings custom-made for this project; include as-designed HVAC layouts, locations of equipment items, refrigerant piping sizes and locations, condensate piping sizes and locations, remote sensing devices, control components, electrical connections, control wiring connections. Include:
 - 1. Detailed piping diagrams, with branch balancing devices.
 - 2. Condensate piping routing, size, and pump connections.
 - 3. Detailed power wiring diagrams.
 - 4. Detailed control wiring diagrams.
 - 5. Locations of required access through fixed construction.
 - 6. Drawings required by manufacturer.
- E. Operating and Maintenance Data:
 - 1. Manufacturer's complete standard instructions for each unit of equipment and control panel.
 - 2. Custom-prepared system operation, troubleshooting, and maintenance instructions and recommendations.
 - 3. Identification of replaceable parts and local source of supply.
- F. Warranty: Executed warranty, made out in Government's name.
 - 1. Standard Warranty: The installation date is the date that the unit is originally commissioned, but no later than 18 months after the manufacture date noted on the unit's rating plate.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Company that has been manufacturing variable refrigerant volume heat pump equipment for at least 5 years.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle equipment and refrigerant piping according to manufacturer's recommendations.

1.06 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Compressors: Provide manufacturer's warranty for 5 years from date of installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Daikin: www.daikinac.com/#sle.
- B. Mitsubishi Electric Trane; mitsubishicomfort.com/commercial
- C. Substitutions: Systems designed and manufactured by other manufacturers will be considered by Government under the terms described for substitutions with the following exceptions:
 - 1. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Substitution requests will be considered only if received at least 10 days prior to the bid date.
 - 3. Substitution requests will be considered only if submitted data meets or exceeds requirements listed in this section.
 - 4. Contractor (not equipment supplier) shall certify that the use of the substitute system and equipment will not require changes to other work or re-design by Contracting Officer or Contracting Officer's Representative.
 - 5. Do not assume substitution has been accepted until formal written notice has been issued by Contracting Officer or Contracting Officer's Representative.

2.02 VARIABLE REFRIGERANT FLOW SYSTEM

- A. Minimum System Requirements:
 - 1. System Testing, Capacity Rating, and Performance:

- a. AHRI 1230 when cooling capacity is equal or greater than 65,000 Btu/h.
 - b. AHRI 210/240 when cooling capacity is below 65,000 Btu/h.
2. Safety Certification: Bear UL 1995 tested and ITS (DIR) listed certification label.
3. Outdoor Units: Furnish installation and surface support hardware products in accordance with ASCE 7 for wind restraint.
4. Cooling Mode Interior Performance: As indicated on contract drawings.

2.03 BRANCH SELECTOR BOXES

- A. Description
 1. The branch selector boxes shall have the capacity to control up to 290 MBH (cooling) downstream of the branch selector box.
 2. Each branch of the branch selector box shall consist of three electronic expansion valves, refrigerant control piping and electronics to facilitate communications between the box and main processor and between the box and indoor units.
 3. The branch selector box shall control the operational mode of the subordinate indoor units.
- B. Multi-port flex branch selector boxes
 1. General
 - a. These branch selector boxes shall provide individual control and changeover for multiple groups of indoor units.
 - b. These branch selector boxes shall allow for Field selectable LEFT/RIGHT/PASS THROUGH piping configuration
 - c. These branch selector boxes shall allow multiple branch selector boxes to be connected downstream of the first Branch selector box in series in series.
 2. Selector boxes for heat recovery
 - a. These Branch selector boxes when connected in series shall be able to support a total indoor load of up to 230MBH.
 - b. The EEV heads and motors used in the branch selector box shall be accessible via a quick access panel without disassembly of the electrical box.
 - c. The electrical box of the 4-port branch selector box shall be field re-locatable to left, right, and back side of the main cabinet.
 - d. These branch selector boxes shall allow connected indoor units to operate in cooling mode down to -4F without any additional field installed accessories.
 - e. Labels shall be displayed close to the incoming 3 pipes to facilitate clear identification and eliminate cross piping.
 - f. The branch selector boxes shall employ EEV with the ability to control up to 6000 pulses.
 - g. These selector boxes shall be factory assembled, wired, and piped.
 3. Selector box piping
 - a. DX refrigeration unit piped to one or more compatible indoor units either directly or indirectly through one or more intermediate refrigeration branch units.
 - b. These selector boxes must be mounted indoors.
 - c. When simultaneously heating and cooling, the units in heating mode shall energize their subcooling electronic expansion valve.

2.04 AIR-SOURCE OUTDOOR UNITS

- A. Manifold two or to three units as recommended by manufacturer to handle sequencing and coordination of multiple indoor units. System to be a heat recovery unit to allow simultaneous heating and cooling.
- B. Unit Cabinet:
 1. Capable of being installed with wiring and piping to the left, right, rear or bottom.
 2. These units shall have a galvanized steel plate casing with baked enamel finish.
 3. The cabinet shall contain one subcooling heat exchanger per branch.

4. Each outdoor unit shall have separate knock-outs for both refrigerant piping and wiring on the bottom panel.
 5. Each cabinet shall house electronic expansion valves for refrigerant control per branch.
 6. Designed to allow side-by-side installation with minimum spacing and vibration isolation.
- C. Compressor
1. Inverter scroll compressors shall be variable speed controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit.
 2. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
 3. Oil separators shall be standard with the equipment together with an intelligent oil management system.
 4. The compressor shall be mounted on vibration dampening rubber grommets to minimize the transmission of vibration, eliminating the standard need for external spring isolation.
- D. Heat Sink Side:
1. Condenser Fans:
 - a. Fan Type: Vertical discharging, direct-driven propeller type with variable speed operation using DC-controlled ECM motors mechanically connected using permanently lubricated bearings having whole assembly protected with fan guards
 2. Condenser Coils:
 - a. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
 - b. The fins shall be coated with an anti-corrosion hydrophilic coating as standard from factory with a salt spray test rating of 1000hr per ASTM B117 test standards.
 - c. The outdoor coil shall have three-circuit heat exchanger design eliminating the need for a drain pan heater. The lower part of the coil shall be used for inverter cooling and be on or off during operation enhancing the defrost operation. or drain pan heater to enable adequate defrosting of the unit in defrost operation.
- E. Refrigeration Side:
1. Factory assembled and wired with instrumentation, switches, and controller(s) to handle unit specifics with direct coordination of remote controller(s) from indoor unit(s).
 2. Refrigerant: R-32, or approved equal refrigerant with global warming potential less than 700, factory charged. Controller to alarm when charge is below capacity.
 3. Integral refrigerant leak gas detectors from factory.
 4. Variable Volume Control: Modulate compressed refrigerant capacity automatically to maintain constant suction and condensing pressures under varying refrigerant volume required to handle remote loads. Include defrost control.
 5. Safety Devices: High pressure sensor with cut-out switch, low pressure sensor with cut-out switch, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, overcurrent protection for the inverter and antirecycling timers.
 6. Oil Recovery Cycle: Automatic, occurring 2 hours after start of operation and then every 8 hours of operation; maintain continuous heating during oil return operation.

2.05 REFRIGERANT PIPING

- A. Two-Pipe Run: Provide low-pressure vapor and high-pressure vapor gas pipes for each indoor unit selected for seasonal heating or cooling service.
- B. Three-Pipe Run: Provide low-pressure vapor, high-pressure vapor gas, and liquid pipes for each indoor unit selected for off-season heating and cooling changeover service or Two-Pipe Run if alternate manufacturer. Alternative manufacturer must meet minimum heating and cooling requirements.

- C. Refrigerant Flow Balancing: Provide refrigerant piping joints and headers specifically designed to ensure proper refrigerant balance and flow for optimum system capacity and performance; T-style joints are prohibited.

2.06 REFRIGERANT BRANCH UNITS

- A. Outdoor unit interface to handle two or more indoor units required to do automatic off-season heating and cooling changeover.
- B. Concealed box consisting internally-piped refrigeration loops, subcooling heat exchanger, and other devices coordinated by electronic valves to facilitate off-season load management between outdoor and indoor units.
- C. Minimum Requirements:
 - 1. Control direction of refrigerant flow using electronic expansion valves; use of solenoid valves for changeover and pressure equalization is not permitted due to refrigerant noise; use of multi-port branch selector boxes is not permitted unless spare ports are provided for redundancy.
 - 2. Provide one electronic expansion valve for each downstream indoor unit served except when multiple indoor units are connected, provide balancing joints in downstream piping to keep total capacity within branch unit capacity.
 - 3. Energize subcooling heat exchanger during simultaneous heating and cooling service.
 - 4. Casing: Galvanized steel sheet with flame and heat resistant foamed polyethylene sound and thermal insulation.
 - 5. Refrigerant Connections: Braze type.
 - 6. Condensate Drainage: Provide unit that does not require condensate drainage.

2.07 INDOOR UNITS

- A. Minimum Unit Requirements:
 - 1. DX Evaporator Coil:
 - a. Copper tubes expanded into aluminum fins to form a mechanical bond; waffle louver fin and high heat exchange, rifled bore tube design; factory tested.
 - b. 2-, 3-, or 4-row cross fin design with 14 to 22 fins per inch and flare end-connections.
 - c. Provide thermistor on liquid and gas lines wired into local controller.
 - d. Refrigerant circuits factory-charged with dehydrated air for field charging.
 - 2. Fan Section:
 - a. Variable or three-speed ECM fan with automatic airflow adjustment; external static pressure selectable during commissioning.
 - b. Thermally protected, direct-drive motor with statically and dynamically balanced fan blades.
 - c. Minimum-adjustable external static pressure 0.32 in-wc; provide for mounting of field-installed ducts.
 - 3. Local Unit Controls:
 - a. Temperature Control: Return air control using thermistor tied to computerized Proportional-Integral-Derivative (PID) control of superheat.
 - b. Temperature Zones:
 - 1) Single Indoor Unit: Set served space(s) as the local temperature zone.
 - 2) Multiple Indoor Units: For large zones, group and coordinate related indoor units with served spaces as the local temperature zone with each indoor unit as sub-zone.
 - 4. Return Air Filter: Standard filter with unit.
 - 5. Condensate:
 - a. Built-in condensate drain pan with PVC drain connection for drainage.
 - b. Units With Built-In Condensate Pumps: Provide condensate safety shutoff and alarm.
- B. 3'x3' Ceiling Cassette, Indoor Units:

1. Ceiling mount, 4-way, supply air flow units with central return air grill, DX coil, tubed drain pan, and built-in controls with thermostat remotely coordinated by outdoor air unit to maintain local air temperature setpoint.
 2. Cabinet Height: Maximum of 10 inches above face of ceiling.
 3. Exposed Housing: White, impact resistant, with washable decoration panel.
 4. Supply Airflow Adjustment:
 - a. Horizontally and vertically adjustable dampers with electronic actuators.
 - b. Four-way distribution field-modifiable to 3-way and 2-way airflow.
 - c. Three auto-swing positions, including standard, draft prevention and ceiling stain prevention
 5. Return air: Shall be through the concentric panel, which includes a resin net mold resistant filter.
 6. The indoor units shall be equipped with a return air thermistor.
 7. Sound Pressure Range: Between 28 to 33 dB(A) at low speed measured at 5 feet below the unit.
 8. Fan: The fan shall be driven by a direct-drive DC motor with statically and dynamically balanced impeller and shall have three user-selectable speeds available: high, medium, and low. The power input required at the three field selectable speeds shall be made available as standard. The airflow rate shall be available in high, medium, and low settings.
 9. Condensate Pump: Built-in with minimum lift of 21 inches and has a built in safety shutoff and alarm.
 10. Condensate Connection: 1 -1/32 inch outside diameter PVC.
 11. Fresh Air Intake: Provide side-mounted outdoor air intake duct connection.
 12. Indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
- C. 2'x2' Ceiling Cassette, Indoor Units:
1. Ceiling mount, 4-way, 2-way, or 1-way supply air flow units with central return air grill, DX coil, tubed drain pan, and built-in controls with thermostat remotely coordinated by outdoor air unit to maintain local air temperature setpoint.
 2. Cabinet Height: Maximum of 10 inches above face of ceiling.
 3. Exposed Housing: White, impact resistant, with washable decoration panel.
 4. Supply Airflow Adjustment:
 - a. Horizontally and vertically adjustable dampers with electronic actuators.
 - b. Four-way distribution field-modifiable to 3-way and 2-way airflow.
 - c. Three auto-swing positions, including standard, draft prevention and ceiling stain prevention.
 5. Return air: Shall be through the concentric panel, which includes a resin net mold resistant filter.
 6. Return Air Filter: The return air shall be filtered by means of a washable long-life filter with mildew proof resin.
 7. The indoor units shall be equipped with a return air thermistor.
 8. Sound Pressure Range: Between 28 to 33 dB(A) at low speed measured at 5 feet below the unit.
 9. Fan: The fan shall be driven by a direct-drive DC motor with statically and dynamically balanced impeller and shall have three user-selectable speeds available: high, medium, and low. The power input required at the three field selectable speeds shall be made available as standard. The airflow rate shall be available in high, medium, and low settings.
 10. Condensate Pump: Built-in with minimum lift of 21 inches and has a built in safety shutoff and alarm.

11. Condensate Connection: 1 -1/32 inch outside diameter PVC
 12. Fresh Air Intake: Provide side-mounted outdoor air intake duct connection.
 13. Indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
- D. Ceiling-Concealed Ducted Indoor Units:
1. The unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall be equipped with automatically adjusting external static pressure logic that is selectable during commissioning. This adjusts the airflow based on the installed external static pressure
 2. Unit Cabinet:
 - a. The unit cabinet shall be constructed of heavy gauge galvanized steel.
 - b. The unit shall be internally insulated and shall be capable of installation in indoor environments up to 80% relative humidity without requiring additional field installed insulation.
 - c. The unit shall ship from the factory in a rear-return configuration and shall be field-convertible to a bottom-return configuration.
 - d. The unit shall be equipped with a return air thermistor
 - e. The cabinet shall be constructed with sound absorbing foamed fiber-less closed cell polystyrene and polyethylene insulation.
 3. Fan:
 - a. The fan shall be a direct-drive, brushless DC fan motor with (3) user-selectable fan speeds (H, M, L).
 - b. The unit shall be equipped with automatically adjusting external static pressure logic selectable during commissioning.
 - c. The unit shall be equipped with internal controls to allow the fan to automatically select the operating fan curve to deliver nominal airflow CFM (within +/- 10%) when the connect ductwork has been designed with a total external static within the range of the unit. This setting shall be accessible as a setting to be used during startup and commissioning of the system
 - d. The fan motor shall be capable of Auto fan speed control when the unit is connected to the local unit controller. The Auto fan speed control shall automatically adjust the unit's fan speed in response to the difference between the indoor unit's current set point and the current room temperature measurement. The Auto fan speed control shall utilize (5) fan speeds.
 - e. The fan motor shall be internally isolated using rubber grommets to reduce transmission of vibrations to the unit.
 - f. The airflow rate shall be available in three settings.
 - g. Fan motor external static (in. w.g) pressure range for nominal airflow:
 - 1) 0.20-0.80 up to nominal 4 ton unit.
 - 2) 0.2 -0.56 for nominal 4.5 ton unit.
 4. Fan Blade:
 - a. The fan blade shall be constructed of lightweight polymer.
 - b. The fan blade shall be statically and dynamically balanced to minimize vibration.
 5. Type: Ducted unit with DX coil, tubed drain pan, and built-in controls with thermostat remotely coordinated by outdoor air unit to maintain local air temperature setpoint.
 6. Sound Pressure: Measured at low speed at 5 feet below unit.
 7. Provide external static pressure switch adjustable for high efficiency filter operation
 8. Condensate Pump: Built-in, with lift of 20 inches, minimum from condensate drain outlet.

- a. The condensate pump shall be equipped with a float switch to automatically stop unit operation and provide a system error code in the event drain pan water level rises too high.
- 9. Condensate Drain: The condensate drain outlet shall be of PVC construction and VP25 (1" ID, 1-1/4" OD).
- 10. Controls
 - a. The unit shall have controls provided by unit manufacturer to perform input functions necessary to operate the system.
 - b. The unit shall be compatible with interfacing with a BMS system via optional BACnet gateways.
 - c. The unit shall be compatible with manufacturer's multi-zone controller.
- 11. Extra Materials:
 - a. Furnish one set of filters for each unit, in addition to the throwaway filters shipped from the factory.
- E. Wall Mounted, Indoor Units:
 - 1. Indoor Unit:
 - a. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The remote controller shall be able to set five (5) steps of discharge angle. The front grille shall be easily removed for washing. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The drain pipe can be fitted to from either left or right sides.
 - b. The indoor units shall be equipped with a return air thermistor.
 - c. Return air shall be through a resin net mold resistant filter.
 - 2. DX coil, tubed drain pan, and built-in controls with thermostat remotely coordinated by outdoor air unit to maintain local air temperature setpoint.
 - 3. Fan: The fan shall be a direct-drive cross-flow fan, statically and dynamically balanced impeller with high and low fan speeds available.
 - 4. Return Air Filter: Manufacturer's standard.
 - 5. Sound Pressure Range: Measured at low speed at 3.3 feet below and away from unit.
 - 6. Condensate Drain Connection: Back, with piping concealed in wall.
 - 7. Cabinet:
 - a. The cabinet shall be affixed to a factory supplied wall mounting template and located in the conditioned space.
 - b. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
 - 8. Control:
 - a. The unit shall have controls provided by unit manufacturer to perform input functions necessary to operate the system.
 - b. The unit shall be compatible with interfacing with a BMS system via optional BACnet gateways.
 - c. The unit shall be compatible with manufacturer's BMS multi-zone controller.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that required electrical services have been installed and are in the proper locations prior to starting installation.
- B. Verify that condensate piping has been installed and is in the proper location prior to starting installation.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install refrigerant piping in accordance with equipment manufacturer's instructions.
- C. Perform wiring in accordance with NFPA 70, National Electric Code (NEC).
- D. Coordinate with installers of systems and equipment connecting to this system.

3.03 SYSTEM STARTUP

- A. Prepare and start equipment and system in accordance with manufacturer's instructions and recommendations.
- B. Adjust equipment for proper operation within manufacturer's published tolerances.

3.04 CLOSEOUT ACTIVITIES

- A. Training: Train Government's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Location: Government's offsite classroom facilities may be used.

3.05 PROTECTION

- A. Protect installed components from subsequent construction operations.
- B. Replace exposed components broken or otherwise damaged beyond repair.

END OF SECTION

**SECTION 23 82 00
CONVECTION HEATING UNITS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Electric unit heaters.
- B. Electric wall heaters.

1.02 RELATED REQUIREMENTS

- A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

1.03 REFERENCE STANDARDS

- A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide typical catalog of information including arrangements.
- C. Shop Drawings:
 - 1. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS**2.01 ELECTRIC UNIT HEATERS**

- A. Manufacturers:
 - 1. INDEECO (Industrial Engineering and Equipment Company): www.indeeco.com/#sle.
 - 2. Modine Manufacturing Company: www.modineHVAC.com/#sle.
 - 3. Trane Technologies, PLC: www.trane.com/#sle.
- B. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to authority having jurisdiction as suitable for purpose indicated.
- C. Heating Element Assembly:
 - 1. Thermal safety cut-out within electric terminal box with automatically reset switch located near electric terminal box.
- D. Housing:
 - 1. Suitable for ceiling or high altitude mount using provided hardware appendages.
- E. Air Inlets and Outlets:
 - 1. Inlets: Provide stamped louvers or protective grilles with fan blade guard.
 - 2. Outlets: Provide diffuser cones, directional louvers, or radial diffusers.
- F. Fan: Factory balanced, direct drive, axial type with fan guard.
- G. Motor: Totally enclosed, thermally protected, and provided with permanently lubricated bearings.
- H. Controls: Wired wall-mounted thermostat or integral thermostat as indicated on contract drawings.

I. Electrical Characteristics:

2.02 ELECTRIC CONVECTORS

- A. Manufacturers:
 - 1. Heatrex: www.heatrex.com/#sle.
 - 2. INDEECO (Industrial Engineering and Equipment Company): www.indeeco.com/#sle.
 - 3. TPI Corporation: www.tpicorp.com/#sle.
 - 4. Marley Engineered Products;
 - 5. Stelpro Design Inc; AMIR - Mirage Convector: www.stelpro.com/#sle.
- B. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to Authority Having Jurisdiction as suitable for the purpose indicated.
- C. Assembly includes linear limit control and automatic reset thermal cutout, with provisions for mounting on wall, floor, or pedestals.
- D. Style: Flat top air outlet and bottom front air inlet.
- E. Heating Elements: Stainless steel elements with aluminum fins and free-floating for noise free operation.
- F. Enclosure:
 - 1. Minimum 20 gauge, 0.0359 inch thick back panel and 16 gauge, 0.0598 inch thick sheet steel, exposed front panel, end caps, corners, and joiner pieces.
 - 2. All joints to snap together without fasteners.
 - 3. Provide removable front panel or access door for servicing and maintenance.
- G. Finish:
 - 1. Factory applied, painted finish.
 - 2. Color: As indicated on drawings.
- H. Electrical Characteristics:

2.03 ELECTRIC WALL HEATERS

- A. Manufacturers:
 - 1. INDEECO (Industrial Engineering and Equipment Company): www.indeeco.com/#sle.
 - 2. Marley Engineered Products: www.marleymep.com/#sle.
 - 3. Trane Technologies, PLC: www.trane.com/#sle.
- B. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to authority having jurisdiction as suitable for purpose indicated.
- C. Heating Elements: Provide open-wire, finned tubular, or resistance wire enclosed in steel sheath.
- D. Cabinet:
 - 1. Minimum 18 gauge, 0.0478 inch thick steel front panel with exposed corners and edges rounded, easily removed panels.
 - 2. Provide required hardware accessories for recessed, semi-recessed, surface, or wall mounting.
- E. Finish:
 - 1. Factory applied, painted finish.
 - 2. Color: As indicated on drawings.
- F. Controls: Wired wall-mounted thermostat or integral thermostat as indicated on contract drawings.
- G. Filter: Easily removed, 1 inch thick glass fiber throw-away type, located to filter air before coil.
- H. Electrical Characteristics: As indicated on contract drawings.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that surfaces are suitable for installation.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Install equipment exposed to finished areas after walls and ceilings are finished and painted.
- C. Unit Heaters:
 - 1. Hang from building structure, with pipe hangers anchored to building, not from piping or electrical conduit.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Coordination of Other Tests and Inspections: Government will employ independent testing agency to test and/or inspect electric unit heater and electric wall heaters; to provide access, and as required to accommodate timely performance.

3.04 PROTECTION

- A. Provide finished cabinet units with protective covers during the balance of construction.

END OF SECTION

**SECTION 23 84 15
STEAM HUMIDIFIERS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Electrode steam humidifiers.

1.02 RELATED REQUIREMENTS

- A. Section 22 10 05 - Plumbing Piping.
- B. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. AHRI 610 (I-P) - Performance Rating of Central System Humidifiers for Residential Applications.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Condaire Inc; EL Series: www.condair.com/#sle.

2.02 ELECTRODE STEAM HUMIDIFIERS

- A. Humidifier: Self-contained, cylinder, microprocessor-controlled, electrode steam-generating unit complying with AHRI 610 (I-P).
- B. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing. Incorporate water fill with 1-inch air gap and integral air gap on drain. Fill solenoid valve shall incorporate built-in strainer, pressure-reducing and flow-regulating orifice.
- C. Electric Service: Unit protected by internal fusing on line voltage leads and automatic emergency drain trigger. Incorporate electrical terminals for installation of humidistat, duct high-limit humidistat, interlock to fan or air flow switch.
- D. Control: Fully modulating control to provide gradual 0 to 100 percent capacity. Maximum capacity shall be field adjustable for 0 to 100 percent. High-water probe shall prevent overfilling. Multiple cylinder humidifiers shall have duplicate internal control circuitry to allow each cylinder to be independently controlled.
 - 1. Standard internal drain water tempering to ensure maximum 140° F [60° C] drain water. External drain water cooler not acceptable.
 - 2. Full cylinder indication and pre-notification of automatic shutdown at end of cylinder life.
 - 3. Automatic pulse feature to clean any obstruction from the drain solenoid valve if required.
 - 4. Modulating output between 20% and 100% of rated capacity.
- E. Integral fill cup with minimum 1-inch [25 mm] air gap to prevent back siphoning.
- F. Steam Distributor: Stainless steel steam dispersion tube suitable for insertion in duct with condensate separator and return leg to remove condensate from distributor and return to humidifier fill. Provide 1-1/2-inch diameter reinforced rubber steam hose from generator to dispersion tube.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions. Relocate existing humidifier and associated components, including steam distributor and controls, as indicated on Contract Drawings.
- B. Install with required clearance for service and maintenance.
- C. Mount humidifier to wall with carbon steel, HILTI Kwik Bolt 3 or equivalent, wedge anchors. Install per manufacturer's recommendations.
- D. Start-up of humidifier to be by factory trained technician.

- E. Provide rigid steam pipes of copper (MED Type-L) or stainless steel (minimum DIN 1.4301) exclusively, and use steam hoses for short distances only 400 mm or less).

END OF SECTION

SECTION 25 05 11
CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS

FPART 1 GENERAL**1.01 CONTROL SYSTEM APPLICABILITY**

- A. There are multiple versions of this Section associated with this project. Different versions have requirements applicable to different control systems. This specific Section applies only to the following control systems:
1. Mechanical HVAC
 2. Lighting Controls
 3. Fire Alarm and Protection

1.02 RELATED REQUIREMENTS

- A. This section does not contain sufficient requirements to procure a control system and must be used in conjunction with other Sections which specify control systems. This Section adds cybersecurity requirements to the control systems specified in other Sections, and as these requirements are conditioned on the control system being provided, there may be requirements in this Section that will not apply to this project. All Sections containing facility-related control systems or control system components are related to the requirements of this Section. Review all specification sections to determine related requirements.
- B. In cases where a requirement is specified in both this Section and in another Section, the more stringent requirement must be met. In cases where a requirement in this Section conflicts with the requirements of another Section such that both requirements cannot be met at the same time, request direction from the {CH#10328046} to determine which requirement applies to the project.

1.03 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
- B. AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)
1. ASHRAE 135
 - a. (2020; Interpretation 1-8 2021; Errata 1-2 2021; Addenda CD 2021; Addenda BV-CE 2022; Interpretation 9-12 2022; Interpretation 13-24 2023; Addenda BV-CF 2023; Errata 3 2023) BACnet—A Data Communication Protocol for Building Automation and Control Networks
- C. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)
1. IEEE 802.1x
 - a. (2010) Local and Metropolitan Area Networks - Port Based Network Access Control
- D. INTERNET ENGINEERING TASK FORCE (IETF)
1. IETF RFC 2819
 - a. (2000) Remote Network Monitoring (RMON) Management Information Base (MIB)
- E. NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)
1. NIST FIPS 140-2
 - a. (2001) Security Requirements for Cryptographic Modules
 2. NIST FIPS 201-2
 - a. (2013) Personal Identity Verification (PIV) of Federal Employees and Contractors
- F. U.S. DEPARTMENT OF DEFENSE (DOD)
1. DODI 8551.01
 - a. (2014) Ports, Protocols, and Services Management (PPSM)
 2. DTM 08-060
 - a. (2008) Policy on Use of Department of Defense (DoD) Information Systems - Standard Consent Banner and User Agreement

1.04 DEFINITIONS

- A. Administrator Account
 - 1. An administrator account is an account with full permissions to a device, application, or operating system, including the ability to create and modify other user accounts.
 - 2. Note that the operating system Administrator Account may be different than Administrator Accounts for applications hosted on that operating system. Also, most controllers will not have any support for accounts and will therefore not have an 'Administrator Account'.
- B. Computer
 - 1. A computer is one of the following:
 - a. a device running a non-embedded desktop or server version of Microsoft Windows
 - b. a device running a non-embedded version of MacOS
 - c. a device running a non-embedded version of Linux
 - d. a device running a version or derivative of the Android Operating System, where Android is considered separate from Linux
 - e. a device running a version of Apple iOS
 - 2. Unless otherwise indicated or clear from context use of the word "device" in this Section includes computers.
- C. Controller
 - 1. A device other than a computer, IP Router, or Ethernet switch. For Fire Protection systems this includes fire alarm control panels, remote operating consoles, and remote annunciators.
- D. Mission Space
 - 1. A device or media is in mission space if physical access to the device or media is controlled by the organization served by the device. For example, a variable air volume (VAV) box controller in a suspended ceiling is in mission space if the VAV box serves that room; an electrical switchgear in an electrical room or an air handling unit (AHU) in a mechanical room or on a rooftop may still be considered to be in mission space if the organization (mission) served by that switchgear or AHU controls access to the electrical room, mechanical room or rooftop. [CH#10328047]
- E. Network
 - 1. A network is a group of two or more devices that can communicate using a network protocol. Network protocols must provide a method for addressing devices on the network; a communication method that does not provide an addressing scheme is not a networked form of communication. Devices that communicate using a method of communication that does not support device addressing are not using a network. Addresses may be other than IP addresses, and addressing may be at either Open Systems Interconnection (OSI) layer 2 or layer 3.
- F. Network Connected
 - 1. A component is network connected (or "connected to a network") only when the device has a network transceiver which is directly connected to the network and implements the network protocol. A device lacking a network transceiver (and accompanying protocol implementation) can never be considered network connected. Note that (unlike many IT definitions of "Network Connected") a device connected to a non-IP network is still considered network connected (an IP connection or IP address is not required for a device to be network connected).
- G. Wireless Network Connected
 - 1. Wireless and bluetooth devices and options are not permitted.
- H. Network Media
 - 1. The thing that provides the communication channel between the devices on a network. Typically wire, but might include wireless, fiber optic, or even power line (some network protocols allow sending network signals over power wiring).
- I. Network Segmentation

1. Segmenting or segregating networks either by logical or physical methods. Examples of logical methods include firewall zones, virtual local area networks (VLANs), or virtual private networks (VPNs). Physical separation is done by deploying additional hardware. Network segmentation is used for isolation of discrete functions or processes. Each network segment will have its own IP address space or subnet.
- J. Operational Technology (OT)
 1. The hardware and software dedicated to detecting and/or causing changes in physical processes through direct monitoring and control of physical devices to accomplish a specific mission in real time.
- K. User Account Support Levels
 1. The support for user accounts is categorized in this Section as one of three levels:
 - a. FULLY Supported
 - 1) Device supports configurable individual accounts. Accounts can be created, deleted, modified, etc. Privileges can be assigned to accounts. These devices support user-based (as opposed to role-based) authentication.
 - b. MINIMALLY Supported
 - 1) Device supports a small, fixed number of accounts (perhaps only one). Accounts cannot be modified. A device with only a "User" and an "Administrator" account would fit this category. Similarly, a device with two PINs for logon - one for restricted and one for unrestricted rights would fit here (in other words, the accounts do not have to be the traditional "username and password" structure). These devices typically only support role-based authentication.
 - 2) Examples of devices which MINIMALLY support accounts are a) a variable frequency drive with a single account which requires a PIN for access to configuration
 - c. NOT Supported
 - 1) Device does not support any Access Enforcement therefore the whole concept of "account" is meaningless.
- L. Manual Local Input
 1. Manual Local Inputs are system analog or binary inputs that are adjustable by a person but are, by intrinsic hardware design, very limited in potential capabilities. Manual Local Inputs do not have touch screens or full keyboards, but may have a few buttons or dials to allow input. Manual Local Inputs do not have full graphic screens or dot-matrix displays, but may have simple lights (LEDs) or 7-segment displays. Manual Local Inputs do not have any sort of menu structure, each button has a single well-defined function.
 2. Examples of Manual Local Inputs are H-O-A switches, simple thermostats, and disconnect switches.
- M. Card Reader
 1. A card reader is an input/output device whose primary function is to assist in two-factor authentication. A card reader must have an interface to read data from a card and may be able to write data to a card. A card reader may have a means (such as buttons, keypad, touchscreen, etc.) for a user to input a PIN or password, as well as a limited display.
- N. User Interface
 1. A User Interface (UI) is something other than a Manual Local Input or Card Reader that allows a person to interact with the system or device. Note that while a Card Reader is not by itself a User Interface, a User Interface may contain a Card Reader in order for it to authenticate its user. Within control systems, there are a wide range of User Interfaces.
 2. Two important distinctions are 1) whether the user interface is Local or Remote, and 2) the effective capabilities of the User Interface to alter data, which is the "privilege" of the user interface (where effective privilege available to a specific user at a specific user interface is the combination of the greatest privilege offered by the user interface and the specific account the user is logged into).
 3. Local User Interface

- a. A Local User Interface is a user interface where the physical hardware the user interacts with (keyboard, buttons, display, etc.) is physically part of the device being affected. All of the relevant characteristics of the user interface are embodied within a single device.
- b. Note that a Local UI may be able to access data in a different device, Local versus Remote in this context refers to the user interface itself; the capability to access data in a different device is covered under "Full User Interface".
- 4. Remote User Interface
 - a. A Remote User Interface implements a Client/Server model where the physical hardware the user interacts with (Client) is physically distinct from the device being affected (Server). Most or all of the security and functionality characteristics of the user interface are defined by the Server, not the Client. The Client and Server communicate via a network connection. A common example of a remote user interface is a web-based interface where the browser (client) is generally on different hardware than the web server (server). A Remote UI remains a Remote UI even if the user happens to be at a Client on the same hardware as the Server. What is important is that a) the Client may be on different hardware than the Server and b) the majority of the security and functional characteristics of the interface are defined at the Server.
 - b. Note that this definition of "remote" is consistent with that generally used in the control industry but is not aligned with the NIST 800-53 definition of "Remote", which refers to "outside the system". The term "Remote" here better aligns with the NIST 800-53 definition of "Network" (remote from within the system) Access.
- 5. Types of User Interface (by capability)
 - a. User interfaces are also categorized by their capabilities as being Read Only, Limited, or Full.
 - b. Read-Only User Interface
 - 1) A Read Only User Interface (also referred to as a View-Only User Interface) is a user interface that only allows for reading data, it does not allow (have the capability to) modify data. A Read Only User Interface may be either Local or Remote. A User Interface that is configured to be Read Only (by some other means than the interface itself, such as using configuration software on a laptop) is a Read-Only Interface. Note a Read Only User Interface may have buttons (or touch screen, etc.) allowing the user to navigate through the presentation of data.
 - 2) Examples of a Read Only User Interfaces are a) a publicly viewable "energy dashboard" showing weather data and energy usage within a building and b) digital wayfinding signage.
 - c. Limited User Interface
 - 1) A Limited User Interface is a user interface that - by design - can only alter information local to the user interface. Note that the determination of "alter" includes only direct interactions, it explicitly excludes interactions that might occur as secondary effects. For example, an interface changing the flow setpoint in a pump controller is a direct interaction, the subsequent change in flow (as well as any subsequent downstream changes in valve position) are not direct interactions.
 - 2) Two examples of LIMITED UIs are:
 - (a) a variable speed drive has a Limited Local User Interface which allows the user to change properties within the drive, but does not allow affecting things outside the drive;
 - (b) a typical home WiFi Router has a Limited Remote User Interface which allows configuration of the Router, but does not allow direct interaction with other devices.
 - d. Full User Interface

- 1) A Full User Interface can alter information in devices outside the device with the user interface. For example, a typical Local Display Panel is a Full Local User Interface while a browser-based front end is a Full Remote User Interface.
- e. View-Only User Interface
 - 1) See Read-Only User Interface
6. Other User Interface Terminology
 - a. In addition to defining whether a user interface is a Hardware Limited, Read-Only, Limited or Full, and whether it is Local or Remote, user interfaces are classified by whether they are writable or privileged.
 - b. Writable User Interface
 - 1) Any User Interface that is not Read-Only is Writable. (Limited User Interfaces and Full User Interfaces are both writable user interfaces (as they are capable of changing a value)).
 - c. Privileged User Interface
 - 1) A Privileged UI is a UI that has sufficient capabilities or functionality that it requires specific cybersecurity measures to be put in place to limit its unauthorized use. Ultimately, whether a specific user interface is considered a Privileged User Interface must be determined by usage.
 - 2) Unless otherwise specified, user interfaces can be determined to be privileged or not using the following:
 - (a) Read-Only User Interfaces are not privileged user interfaces.
 - (b) User Interfaces that can inhibit or force the activation of a fire suppression system (e.g. such as for a pre-action or deluge system) are always privileged user interfaces. Other Full User interfaces for Fire Alarm Systems are privileged user interfaces as indicated and shown, or when another requirement of this Section establishes they are privileged. For all other systems, Full User Interfaces are privileged user interfaces.
 - (c) User interfaces that allow for configuration of auditing or allows for modification or deletion of audit logs are privileged user interface.
 - (d) User interfaces that allow for reprogramming a network connected device is a privileged user interface.
 - (e) Writeable User Interfaces in Electronic Security Systems (ESS) are privileged user interfaces.
 - (f) Except as specified above, a Limited User Interface must be determined to be privileged or not based on the specific capabilities and use case of the user interface. In general however, user interfaces that do not offer significant capabilities above and beyond those available at that location via other means (e.g. such as a disconnect switch, breaker, or hand-off-auto switch, or physical attack) are not privileged.
- O. Wireless Network
 1. Wireless and bluetooth devices and options are not permitted.
- P. Wired Broadcast Network
 1. Wired Broadcast Networks are any network, such as powerline carrier networks and modem (wired telephony), that use wire-based technologies where there is not a clearly defined boundary for signal propagation.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Points of Contact
 1. Coordinate with the following Points of Contact as indicated in this Section and as required. Not all projects will require coordination with all Points of Contact. When coordination is required and no Point of Contact is indicated, coordinate with the Contracting Officer (KO).
 2. Government Computer Access Point of Contact: Contracting Office (KO).
 3. HTTPS Certificate Point of Contact: Contracting Officer (KO)

4. Email Address Point of Contact: Contracting Officer (KO)
 5. Password Point of Contact: Contracting Officer (KO)
 6. Mobile Code Point of Contact: Contracting Officer (KO)
 7. PKI Infrastructure Point of Contact: Contracting Officer (KO)
- B. Coordination
1. Coordinate the execution of this Section with the execution of all other Sections related to control systems as indicated in the paragraph RELATED REQUIREMENTS. Items that must be considered when coordinating project efforts include but are not limited to:
 - a. If requesting permission for wireless or wired broadcast communication, the Wireless and Wired Broadcast Communication Request submittal must be approved prior to control system device selection and installation.
 - b. If requesting permission for alternate account lock permissions, the Device Account Lock Exception Request must be approved prior to control system device selection and installation.
 - c. If requesting permission for the use of a device with multiple physical connections to IP networks, the Multiple IP Connection Device Request must be approved prior to control system device selection and installation.
 - d. Wireless testing may be required as part of the control system testing. See requirements for the Wireless Communication Test Report submittal.
 - e. If the Device Audit Record Upload Software is to be installed on a computer not being provided as part of the control system, coordination is required to identify the computer on which to install the software.
 - f. The Cybersecurity Interconnection Schedule must be coordinated with other work that will be interconnected to, and interconnections must be approved by the Government before relying on them for system functionality.
 - g. Cybersecurity testing support must be coordinated across control systems and with the Government cybersecurity testing schedule.
 - h. Passwords must be coordinated with the indicated contact for the project site.
 - i. If applicable, HTTPS web server certificates must be obtained from the indicated HTTPS Certificate Point of Contact.
 - j. Contractor Computer Cybersecurity Compliance Statements must be provided for each contractor using contractor owned computers.

1.06 SUBMITTALS

- A. Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for Contractor Quality Control approval. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:
- B. SD-01 Preconstruction Submittals
1. Wired Broadcast Communication Request; G,
 2. Device Account Lock Exception Request; G,
 3. Multiple Ethernet Connection Device Request; G,
 4. Contractor Computer Cybersecurity Compliance Statements; G,
 5. Contractor Temporary Network Cybersecurity Compliance Statements; G,
 6. Cybersecurity Interconnection Schedule (Encrypted); G,
 7. Protection of Information At Rest Proposal; G,
 8. Proposed STIG and SRG Applicability Report; G,
 9. Pre-Construction Control System Inventory Report (Encrypted); G,
 10. Contractor Personnel Certifications; G,
 11. USACE OT/Control Systems Acceptable Use Policy (AUP); G,
 12. Account Level Permissions List (Encrypted); G,
- C. SD-02 Shop Drawings

1. Network Communication, Ports, Protocols and Services Report; G,
 2. Cybersecurity Network (Riser) Diagram (Encrypted); G,
 3. System Data Flow Diagram (Encrypted); G,
- D. SD-03 Product Data
1. Control System Cybersecurity Documentation; G,
 2. Certificate Protection Status (Encrypted); G,
- E. SD-06 Test Reports
1. Control System Cybersecurity Testing Procedures; G,
 2. Control System Cybersecurity Testing Report; G,
 3. Antivirus/Antimalware Scan Results; G,
- F. SD-07 Certificates
1. Software Licenses; G,
- G. SD-11 Closeout Submittals
1. Confidential Password Report; G,
 2. Password Change Summary Report; G,
 3. Enclosure Keys; G,
 4. Software and Configuration Backups (Encrypted); G,
 5. Auditing Front End Software; G,
 6. Device Audit Record Upload Software; G,
 7. System Maintenance Tool Software; G,
 8. Control System Scanning Tools; G,
 9. STIG, SRG and Vendor Guide Compliance Result Report (Encrypted); G,
 10. Final Control System Inventory Report (Encrypted); G,
 11. Integrity Verification Software; G,
 12. Vulnerability Resolution Report; G,
 13. BIOS/UEFI Protection Password/Passphrase List (Encrypted); G,

1.07 ENCRYPTED SUBMITTAL REQUIREMENTS

- A. Submittals with sensitive data are marked with "(encrypted)" and must be encrypted with NIST FIPS 140-2 compliant encryption methods with a password that meets the requirements under paragraph PASSWORDS. Encrypted submittals must be sent via DoD SAFE (<https://safe.apps.mil/>) and only sent to those who need to know. If DoD SAFE is not available, the government will provide an alternative secure file transfer that must be used. Do not store encrypted submittals on shared storage systems. Store and send encrypted information separately than the password.

1.08 QUALITY CONTROL

- A. Regulatory Requirements
1. For the {CH#10328048} control system: {CH#10328049}.
- B. {CH#10328050}
1. For the {CH#10328051} control system: {CH#10328052}.
- C. Certifications
1. Personnel performing cybersecurity functions must have current {CH#10328053} certification according to approved DoD IA baseline certifications. Provide Contractor Personnel Certifications no later than 30 days following Notice To Proceed. A cybersecurity function includes security-relevant functions that ordinary users are not authorized to perform. Examples of these activities include, but are not limited to, creating/modifying user accounts, configuring auditing levels, configuring functionality of a device that is restricted from general users, network architecture design, and applying secure configuration to an Operating System or device. See <https://public.cyber.mil/cwmp/dod-approved-8570-baseline-certifications/>.

- D. Personnel who will have access to make changes to the OT system must read, agree to, and sign the USACE OT/Control Systems Acceptable Use Policy (AUP), provided by the government prior to accessing the OT system. Provide signed AUPs no later than {CH#10328054} days after notice to proceed.
- E. Pre-Construction Testing
 - 1. For the control system: {CH#10328056}.

1.09 CYBERSECURITY DOCUMENTATION

- A. {For Government Reference Only: This subpart (and its subparts) relates to PL-7; CCI-003071}
- B. Proposed STIG and SRG Applicability Report
 - 1. For each model of network connected or network infrastructure device, use the DISA SRG/STIG Applicability Guide and Collection Tool (available at <https://public.cyber.mil/stigs/SCAP/>) to identify applicable STIGs or SRGs and provide a report indicating applicable STIGs and SRGs for each model. Provide the Proposed STIG and SRG Applicability Report concurrently with the Pre-Construction Control System Inventory Report.
- C. Cybersecurity Interconnection Schedule (Encrypted)
 - 1. {For Government Reference Only: This subpart relates to CA-3(b), PL-8, SC-7(9), SC-7(11); CCI-000258, CCI-003072, CCI-003073, CCI-003075, CCI-002398, CCI-002399, CCI-002401, CCI-002402, CCI-002403.
 - 2. For MODERATE Impact systems, this subpart also relates to SC-7; CCI-001126, CCI-001109}
 - 3. Provide a completed Cybersecurity Interconnection Schedule documenting network connections between the installed system and other systems. Provide the following information for each device directly communicating between systems: Device Identifier, Device Manufacturer, Device Description, Transport layer Protocol, Network Address, Port (if applicable), MAC (Layer 2) address (if applicable), Media, Application Protocol, Service (if applicable), Descriptive Purpose of communication. For communication with other authorized systems also provide the Foreign Destination and POC for Destination. For MODERATE Impact Systems: Also describe the impact of loss of the connection on the control system. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.
 - 4. In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Cybersecurity Interconnection Schedule as an editable Microsoft Excel file (a template Cybersecurity Interconnection Schedule in Excel format is available at <https://www.wbdg.org/dod/ufigs/ufigs-25-05-11>.)
- D. Network Communication, Ports, Protocols and Services Report
 - 1. {For Government Reference Only: This subpart (and its subparts) relates to CA-9, PL-8; CCI-002102, CCI-002103, CCI-002104, CCI-002105, CCI-003072, CCI-003073, CCI-003075 and also the submittal requirements associated with CM-6, CM-7, including CM-7(3), CCI-000388.}
 - 2. Provide a Network Communication, Ports, Protocols and Services Report. For each networked device, document device identifier and the communication characteristics of the device including communication protocols, services used, encryption employed, and a general description of what information is communicated over the network. For each device using IP communication, document all TCP and UDP ports used. For each device using non-IP communication, document communication protocol and media used. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.
 - 3. In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Network Communication, Ports, Protocols and Services Report as an editable Microsoft Excel file.
- E. Control System Inventory Reports

1. {For Government Reference Only: This subpart (and its subparts) relates to CM-8(a), SI-17, IA-3; CCI-000389, CCI-000392, CCI-000398, CCI-002773, CCI-002774, CCI-002775, CCI-000777, CCI-000778, CCI-001958}
 2. Provide a Pre-Construction Control System Inventory Report (Encrypted) report and a Final Control System Inventory Report (Encrypted), using the {CH#10328059} listed under this Section at <https://www.wbdg.org/dod/ufgs/ufgs-25-05-11>. In the Control System Inventory Reports, document all {CH#10328060}, and all software. For each device provide all applicable information for which there is a field on the spreadsheet in accordance with the instructions on the spreadsheet.
 3. In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Control System Inventory Reports as editable Microsoft Excel files. Provide the Pre-Construction Control System Inventory Report concurrently with the Proposed STIG and SRG Applicability Report
- F. System Data Flow Diagram (Encrypted)
1. Submit a system data flow diagram (encrypted) a minimum of 60 days prior to installed operation of the equipment. Provide diagrams electronically in PDF as well as either Microsoft Visio (VSDX) or Microstation (DGN), formatted for 11" x 17" sheets. Include:
 - a. All devices that communicate via routable protocols.
 - b. The normal system communications among the devices on the network, including the ports and protocols utilized for communications
 - c. Arrows to indicate direction of data flow between components. Define the physical media and protocol for each link.
 - d. Logical boundary of the system marked with a red line clearly defining components inside the boundary as well as components outside the boundary. Label connections to external networks and indicate the boundary protection.
 - e. Indicate VLAN segmentation of the devices on the diagram.
- G. Software and Configuration Backups (Encrypted)
1. {For Government Reference Only: This subpart (and its subparts) relates to CP-10; CCI-000550, CCI-000551, CCI-000552}
 2. For each computer on which software is installed under this project, provide a recovery image of the final as-built computer on an encrypted external hard drive. This image must allow for bare-metal restore such that restoration of the image is sufficient to restore system operation to the imaged state without the need for re-installation of software. If additional user permissions are required to meet this requirement, coordinate the creation of the image with the identified Government Computer Access Point of Contact.
 3. For all Ethernet switches provide a backup of the switch configuration. For all controllers, provide a backup of the controller configuration and the source code for all loaded application programs (all software that is not common to every controller of the same manufacturer and model).
 4. Test backups to verify as functional for restoring the system prior to submittal. Include verification of testing and functionality with submittal. If any or all of these are provided under another Section, provide documentation indicating this and referencing those submittals.
- H. Cybersecurity Network (Riser) Diagram (Encrypted)
1. {For Government Reference Only: This subpart (and its subparts) relates to PL-2(a), PL-8; CCI-003051, CCI-003053, CCI-003072, CCI-003073, CCI-003075}
 2. Provide a cybersecurity network (riser) diagram of the complete control system including all network and device hardware. For each device, include the device identifier, device type, and manufacturer. If the control system specifications require a riser diagram submittal, provide a copy of that submittal as the cybersecurity riser diagram. Otherwise, provide a riser diagram in {CH#10328061}.
 3. Provide diagrams electronically in Portable Document Format (PDF) as well as either Microsoft Visio (VSDX) or Microstation (DGN), formatted for 11" x 17" sheets.

- I. STIG, SRG and Vendor Guide Compliance Result Report (Encrypted)
 - 1. For every component (device or software) with an applicable STIG or SRG in the Proposed STIG and SRG Applicability Report, document compliance with the STIG or SRG requirements.
 - a. For components which are scannable by {CH#10328062} [the Evaluate-STIG tool (available online at (CAC Required), include the Evaluate-STIG] report and raw scan results in addition to the final, manually reviewed and revised, documentation of compliance with STIG and SRG requirements. Checklist files should not contain any findings with a Not Reviewed (NR) status after manual reviews.
 - b. For components which do not support automated scanning, a manual review using the General Purpose STIG option should be done. A completed Checklist file should not contain any findings with a Not Reviewed (NR) status after manual reviews
 - 2. For every component (device or software) with manufacturer provided cybersecurity documentation, procedure, or method for secure configuration or installation, provide a report documenting how the component was configured and any deviation from the manufacturer instructions.
 - 3. STIG, SRG and Vendor Guide Compliance Result Report Deviations List
 - a. Within the STIG, SRG and Vendor Guide Compliance Result Report, include a Deviations List documenting all deviations required for system operation, and reasons why a STIG, patch, firmware update, or other requirement cannot be met. Include for each deviation:
 - 1) STIG, SRG, Patch, Firmware Update, or other requirement being deviated
 - 2) Vulnerability Identification
 - 3) Rule Identification
 - 4) Control
 - 5) Control Correlation Identifier (CCI)
 - 6) Finding
 - 7) Justification
 - 8) Current Risk-Mitigation Actions
- J. Control System Cybersecurity Documentation
 - 1. {For Government Reference Only: This subpart (and its subparts) relates to SA-5(a), SA-5(b), SA-5(c), SA-22(b); CCIs: CCI-003124, CCI-003125, CCI-003126, CCI-003127, CCI-003128, CCI-003129, CCI-003130, CCI-003131, CCI-003374}
 - 2. Provide a Control System Cybersecurity Documentation submittal containing the indicated information for each device and software application.
 - 3. Software Applications
 - a. For all software applications running on computers provide:
 - 1) administrator documentation that describes secure configuration of the software {For Government Reference Only: relates to CCI-003124}
 - 2) administrator documentation that describes secure installation of the software and software updates. {For Government Reference Only: relates to CCI-003125}
 - 3) administrator documentation that describes secure operation of the software {For Government Reference Only: relates to CCI-003124}
 - 4) administrator documentation that describes effective use and maintenance of security functions or mechanisms for the software {For Government Reference Only: relates to CCI-003127}
 - 5) administrator documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the software {For Government Reference Only: relates to CCI-003128}
 - 6) user documentation that describes user-accessible security functions or mechanisms in the software and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

- 7) user documentation that describes methods for user interaction which enables individuals to use the software in a more secure manner {For Government Reference Only: relates to CCI-003130}
- 8) user documentation that describes user responsibilities in maintaining the security of the software {For Government Reference Only: relates to CCI-003131}
4. For HVAC Control System Devices
 - a. HVAC Control System Devices FULLY Supporting User Accounts
 - b. For all HVAC Control System Devices which FULLY support user accounts, provide:
 - 1) Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}
 - 2) Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}
 - 3) Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}
 - 4) Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}
 - 5) Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms; or a specific indication that there are no user-accessible security functions or mechanisms in the device {For Government Reference Only: relates to CCI-003129}
 - 6) Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}
 - c. All Other HVAC Control System Devices
 - 1) For all HVAC Control System Devices which do not FULLY support user accounts, provide:
 - 2) Documentation that describes secure configuration of the device; or a specific indication that there are no secure configuration steps that apply {For Government Reference Only: relates to CCI-003124}
 - 3) Documentation that describes effective use and maintenance of security functions or mechanisms for the device; or a specific indication that there are no security functions or mechanisms in the device {For Government Reference Only: relates to CCI-003127}
 - 4) For devices which include a user interface, documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}
5. For Lighting Control System Devices
 - a. Wireless and bluetooth devices and options are not permitted.
 - b. All Other Lighting Control System Devices
 - 1) For all Lighting Control System Devices which do not FULLY support user accounts, provide:
 - 2) Documentation that describes secure configuration of the device; or a specific indication that there are no secure configuration steps that apply {For Government Reference Only: relates to CCI-003124}
 - 3) Documentation that describes effective use and maintenance of security functions or mechanisms for the device; or a specific indication that there are no security functions or mechanisms in the device {For Government Reference Only: relates to CCI-003127}

- 4) For devices which include a user interface, documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}
6. Default Requirements for Control System Devices
 - a. For control system devices where Control System Cybersecurity Documentation requirements are not otherwise indicated in this Section, provide:
 - 1) Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}
 - 2) Documentation that describes secure installation of the device {For Government Reference Only: relates to CCI-003125}
 - 3) Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}
 - 4) Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}
 - 5) Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}
 - 6) Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}
 - 7) Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}
 - 8) Documentation that describes user responsibilities in maintaining the security of the device {For Government Reference Only: relates to CCI-003131}
 - 9) Documentation of the published last date of support by the manufacturer or indication that a published date is not available. {For Government Reference Only: relates to CCI-003374}
- K. SOFTWARE LICENSING
- L. {For Government Reference Only: This subpart (and its subparts) relates to SI-2(a), SI-2(c), SI-7(14); CCI-001227, CCI-002605, CCI-002737}
- M. For all software provided that has not already been licensed to the government or project site, provide a license to the {CH#10328063} for a period {CH#10328064}, and the license must also include the following software updates:
 1. Security and bug-fix patches issued by the software manufacturer.
 2. Security patches to address any vulnerability identified in the National Vulnerability Database at <http://nvd.nist.gov> with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.
- N. Provide a single Software Licenses submittal with documentation of the software licenses for all software provided

1.10 CYBERSECURITY DURING CONSTRUCTION

- A. {For Government Reference Only: This subpart (and its subparts) relates to AC-18, CA-3; CCI-000258}
- B. In addition to the control system cybersecurity requirements indicated in this section, meet following requirement throughout the construction process.
- C. Contractor Computer Equipment
 1. Contractor owned computers may be used for construction. Contractor computers connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:
 - a. Operating System

- 1) The operating system must be an operating system currently supported by the manufacturer of the operating system. The operating system must be current on security patches and operating system manufacturer required updates.
- b. Anti-Malware Software
 - 1) The computer must run anti-malware software from a reputable software manufacturer. Anti-malware software must be a version currently supported by the software manufacturer, must be current on all patches and updates, and must use the latest definitions file. Computers used on this project must perform a full antivirus scan at least once per day. Computers which have connected to any other network since the last full antivirus scan must perform a full antivirus scan prior to connection to the control system network or to the temporary contractor-installed IP network. Perform an antivirus scan on all removable media (e.g., external hard drives, CDs, DVDs, USB flash drives) prior to connecting to the control system environment.
- c. Passwords and Passphrases
 - 1) The passwords and passphrases for computers, applications, and web-based applications supporting passwords must be changed from their default values. Passwords must be a minimum of eight characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.
- d. User-Based Authentication
 - 1) Each user must have a unique account; sharing of a single account between multiple users is prohibited.
- e. Firewall
 - 1) Computers must have a firewall enabled and set to "public".
- f. Encryption
 - 1) Employ data-at-rest encryption to protect information stored on the device. The types of information that must be protected include site specific drawings, configuration files, project files, vulnerability data, and any other specific information that could potentially lead to a compromise. Immediately notify the Contracting Officer in the event that a Contractor-owned computer that stores this information is lost or stolen.
- g. Demonstration of Compliance
 - 1) The Government has the right to require demonstration of computer compliance with these requirements at any time during the project.
- h. Contractor Computer Cybersecurity Compliance Statements
 - 1) Provide a single submittal containing completed Contractor Computer Cybersecurity Compliance Statements for each company using contractor owned computers. Contractor Computer Cybersecurity Compliance Statements must use the template published at
- D. Temporary IP Networks
 1. Temporary contractor-installed IP networks may be used during construction. When used, temporary contractor-installed IP networks connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:
 2. Network Boundaries and Connections
 3. The network must not extend outside the project site and must not connect to any IP network other than those specifically provided or furnished for this project. Any and all access to the network from outside the project site is prohibited.
- E. Government Access to Network
 1. Government personnel must be allowed to have complete and immediate access to the network at any time in order to verify compliance with this specification.
- F. Temporary Wireless IP Networks
 1. In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks, when permitted, must not interfere with existing wireless networks, must

- use WPA2 security and must not broadcast the network name (SSID). Network names (SSID) for wireless networks must be changed from their default values.]
- 2. Temporary wireless networks are NOT PERMITTED.
- G. Passwords and Passphrases
 - 1. The passwords and passphrases for all network devices and network access must be changed from their default values. Passwords must be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.
- H. Contractor Temporary Network Cybersecurity Compliance Statements
 - 1. Provide a single submittal containing completed Contractor Temporary Network Cybersecurity Compliance Statements for each company implementing a temporary IP network. Contractor Temporary Network Cybersecurity Compliance Statements must use the template published at <https://www.wbdg.org/dod/ufigs/ufigs-25-05-11>. Each Statement must be signed by a cybersecurity representative for the relevant company. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

1.11 CYBERSECURITY DURING WARRANTY PERIOD

- A. All work performed on the control system after acceptance must be performed using Government Furnished Equipment or equipment specifically and individually approved by the Government.

PART 2 PRODUCTS

ALL PRODUCTS USED ON THIS PROJECT MUST MEET THE INDICATED REQUIREMENTS.

2.01 ETHERNET SWITCH

- A. Provide Open Systems Interconnection (OSI) Layer 2 Ethernet switches with the following capabilities, and with an interface to support switch configuration for these capabilities:
- B. Required Functionality
 - 1. Switches must:
 - a. Copper Ethernet ports must auto negotiate for 10, 100 and 1000 megabits-per-second links.
 - b. Be capable of implementing port level access control by MAC address and limit the number of MAC addresses to one MAC address per port.
 - c. For MODERATE Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.
 - d. For LOW Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.
 - e. Support Remote Network Monitoring (RMON) Port Analysis in accordance with IETF RFC 2819
 - f. Configure target port and analysis port such that switch clones all target port traffic to analysis port.
 - g. Support authentication via RADIUS server (for management and 802.1x)
 - h. Support IEEE 802.1x network login.
- C. Configuration Requirements
 - 1. Switches must:
 - a. Support configuration save and restore.
 - b. Support both manual IP address assignment and acquisition of a dynamic IP address via Dynamic Host Configuration Protocol (DHCP).
 - c. Be capable of limiting access for configuration to one or more of: a web interface using HTTPS, a command line interface using SSH, or an SNMP connection using SNMP version 3 or later.
 - d. Support the ability to lock configuration capability to a dedicated management port.]

2.02 DAISY CHAIN IP CONTROLLERS

- A. Controllers used as Daisy Chain IP Controllers must be IP controllers with exactly two Ethernet network connections and basic built-in switch capabilities to allow implementation of an Ethernet network in a daisy chain architecture. Switches incorporated by Daisy Chain IP Controllers are not required to meet the requirements for Ethernet Switches as defined in this Section.

2.03 DATABASE AND WEB SERVER SOFTWARE FOR MODERATE IMPACT SYSTEMS

- A. {For Government Reference Only: This subpart (and its subparts) relate to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906}
- B. All computer-based databases must use {CH#10328065} [or] Oracle. All computer-based web interfaces must use Internet Information Services (IIS) as the web server.

2.04 LOCKABLE ENCLOSURES WITH PADLOCK

- A. Provide lockable enclosures with lockable handles, doors, or accessories allowing the cabinet to be secured using a padlock. Provide a stainless steel padlock with a minimum of a 3/8-inch diameter hardened shackle for each enclosure.

PART 3 EXECUTION

3.01 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES

- A. Install, configure, and harden all hardware and software furnished on this project in accordance with manufacturer provided documentation, procedures, or methods for secure configuration or installation. Configure hardware and software in accordance with the applicable STIGs and SRGs per the STIG and SRG applicability report. Install the most current versions of operating systems, software updates, firmware updates, security patches, service packs, and BIOS/UEFI, unless otherwise specified or approved. Do not implement specific hardening actions if that action would conflict with required functionality or another requirement of this Section.

3.02 NETWORK REQUIREMENTS

- A. Information Flow Enforcement In MODERATE Impact Systems
 - 1. {For Government Reference Only: This subpart (and its subparts) relate to AC-4; CCI-001368, CCI-001414, CCI-001548, CCI-001549, CCI-001550, CCI-001551}
 - 2. Install and configure Ethernet switches to block all traffic on all ports not required by the control protocol.
- B. Wireless and Wired Broadcast Communication for Fire Protection Systems
 - 1. The use of wireless and wired broadcast communication for fire protection systems within a facility is prohibited.
 - 2. Wireless communication may be used to provide communication from the fire protection system in a facility to the central monitoring station. Communication between the fire protection system and the central monitoring station must be via FIPS 140-2 certified devices.
- C. Wireless and Wired Broadcast Communication for Systems Other than Fire Protection Systems
 - 1. {For Government Reference Only: This subpart (and its subparts) relates to AC-18, AC-18(3); CCI-001438, CCI-001439, CCI-002323, CCI-001441, CCI-001449}
 - 2. Unless explicitly authorized by the Government, do not use any wireless or bluetooth communication.
 - 3. Wired Broadcast Communication Request
 - a. Provide a report documenting the proposed use of wired broadcast communication prior to device selection using the Wired Broadcast Communication Request Schedule at <https://www.wbdg.org/dod/ufgs/ufgs-25-05-11>. If there is no proposed use of wired broadcast communication, provide a document indicating this instead of the Request Schedule.
 - b. For each device proposed to use wired broadcast communication show: the device identifier, a description of the device, the location of the device, the device identifiers

of other devices communicating with the device, the protocol used for communication, encryption type and strength.

D. Non-IP Control Networks

1. When control system specifications require particular communication protocols, use only those communication protocols and only as specified. Do not implement any other communication protocol.
2. When control system specifications do not indicate requirements for communication protocols, use only those protocols required for operation of the system as specified.

E. IP Control Networks

1. {For Government Reference Only: This subpart relates to CM-6(a), CM-7(a), CM-7(b), CM-7(1)(b), SC-41; CCI-001588, CCI-000381, CCI-000380, CCI-000381, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546.
2. For Moderate Impact Systems, this subpart (and its subparts) also relates to SC-5(1), SC-5(2); CCI-001094 CCI-001095}
3. IP Networks must be Ethernet networks and must use switches which are Ethernet Switches or Daisy Chain IP Controllers as defined in this Section.
 - a. Do not use nonsecure functions, ports, protocols and services as defined in DODI 8551.01 unless those ports, protocols and services are specifically required by the control system specifications or otherwise specifically authorized by the Government.
 - b. Do not use ports, protocols and services that are not specified in the control system specifications or required for operation of the control system.
4. For MODERATE Impact Systems, unless explicitly authorized, do not use IP networks if the same control functionality is available through the use of non-IP networks.
5. IP Network Routers
 - a. For IP-based communications across control systems, use Routers to control and restrict traffic flow between network and virtual local area network (VLAN) traffic. Configure routers using Access Control Lists (ACLs) using a deny-all, permit by exception approach. When network traffic is within the local perimeter use Traditional Network Routers. When network traffic leaves the local perimeter, use Integrated Service Routers (ISR) or Firewalls with VPN capability instead.]
 - b. Do not install any device that performs IP routing.
6. IP Devices With Multiple Ethernet Connections
7. Except for Ethernet Switches and Daisy Chain IP Controllers, devices must not have more than one Ethernet connection to IP networks unless doing so is required by the project specifications and the specific application is approved. If a device with Multiple Ethernet Connections to IP networks is required, provide a Multiple Ethernet Connection Device Request using the Multiple Ethernet Connection Device Request Template at <https://www.wbdg.org/dod/ufgs/ufgs-25-05-11> to request approval for each device. If a device with Multiple Ethernet Connections to IP networks is not required, instead provide a document stating that no approval is being requested.

F. Cryptographic Protection

1. {For Government Reference Only: This subpart relates to IA-2(9), IA-3(1), SC-8, SC-13, SC-23(1), SC-23(3); CCI-001942, CCI-001959, CCI-001967, CCI-002418, CCI-002449, CCI-002450, CCI-001185, CCI-001188, CCI-001664.}
2. All remote user interfaces must use HTTPS for all traffic between the user interface client and user interface server.
3. For devices that have STIG/SRGs related to cryptographic protection (CCI-002450), comply with the requirements of those STIG/SRGs.
 - a. Ensure that {CH#10328070} network traffic is encrypted using NSA-approved cryptography; provision of digital signatures and hashing, and FIPS-validated cryptography.

G. Additional Cryptographic Protection Requirements for USACE Civil Works Systems

- a. Protect the following communications using NIST FIPS 140-2 compliant encryption methods:
 - 1) Any wireless communication
 - b. Establish Virtual Private Network IPsec tunnels between different facilities and between wireless devices. Provide firewalls to control communications between tunnels. Firewalls must meet STIG requirements. Network and wireless devices must be on the DISA approved product list (APL). See <https://aplits.disa.mil/processAPList>.
- H. Device Identification and Authentication
 - 1. {For Government Reference Only: This subpart (and its subparts) relates to IA-3; CCI-000777, CCI-000778, CCI-001958.
 - 2. For MODERATE Impact systems, this subpart (and its subparts) also relates to SC-23, SC-23(5); CCI-001184, CCI-002470.}
 - 3. All computers must support {CH#10328071} IEEE 802.1x for device authentication to the network.
 - 4. For HVAC Control System Devices
 - a. Devices using HTTP as a control protocol must use HTTPS instead. {CH#10328072}
 - 5. For Lighting Control System Devices
 - a. Devices using HTTP as a control protocol must use HTTPS instead. Devices using Fox Protocol must support IEEE 802.1x. Devices using Ethernet must support IEEE 802.1x. Devices using BACnet must support network security as specified for BACnet Secure Connect in ASHRAE 135.
 - 6. Default Requirements for Control System Devices
 - a. For control system devices where Device Identification and Authentication requirements are not otherwise indicated in this Section: {CH#10328074} Devices using HTTP as a control protocol must use HTTPS instead. Cryptographic Module Authentication
 - b. {For Government Reference Only: This subpart (and its subparts) relates to IA-7; CCI-000803}
 - c. For devices (including but not limited to NIST FIPS 140-2 compliant radios) that have STIG/SRGs related to cryptographic module authentication (CCI-000803), comply with the requirements of those STIG/SRGs.
- I. Secure Network Design
 - 1. Provide network segmentation for networks leaving a local physical boundary, containing multiple types of systems (such as control and electronic security systems), or controlling more than one process that does not require direct communication of the control system components amongst discrete processes. Dual-homed hosts are prohibited. Protect external connections to the outside with a router, firewall, VPN, and IDS.
 - 2. Network Interface Cards (NICs) or network transceivers are considered to be network connected regardless of network protocol used. Unused NICs must be disabled. A device is considered to be wireless network connected unless the wireless network controller is physically disabled. It is not sufficient to disable the wireless NIC in settings.
- J. OT Monitoring System (OTMS)
 - 1. Provide {CH#10328075} of rack space for data taps to be furnished, installed, and configured by the Government.

3.03 ACCESS CONTROL REQUIREMENTS

- A. User Accounts
 - 1. {For Government Reference Only: This subpart (and its subparts) relate to AC-2(a), AC-3, AC-6(1), AC-6(10), AC-6(2), AC-6(9), CM-11(2), and IA-2; CCI-002110, CCI-000213, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-001812, and CCI-000764.
 - 2. For MODERATE Impact systems, this subpart (and its subparts) also relate to AC-2 (2), AC-2(3), AC-2(4), AC-6(1), and CM-5(1); CCI-001361, CCI-000017, CCI-000217, CCI-000018, CCI-001403, CCI-001404, CCI-001405, CCI-002130, CCI-001683, CCI-001684,

CCI-001685, CCI-001686, CCI-002132, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-001813.}

3. Any user interface supporting user accounts (either FULLY or MINIMALLY) must limit access according to specified limitations for each account. Install and configure any device having a STIG or SRG in accordance with that STIG or SRG.
4. All user interfaces FULLY supporting accounts must implement user-based authentication where each account is uniquely assigned to a specific user. User interfaces FULLY supporting accounts must implement at least three (3) levels of user account privilege including: 1) an account with read-only permissions 2) an account with full permissions including account creation and modification and 3) an account with greater permissions than read-only but without account creation and modification. Disable any unnecessary or unused accounts. Disable any "guest-level" accounts that are created on the system by default.
5. Computers
 - a. All computer operating systems must FULLY support user accounts and implement accounts for access. Each control system software application not supporting accounts and running on a computer must be installed such that use of the software is restricted by the computer operating system to specific users.
 - b. Applications running on computers must not require the user be logged in to a computer operating system administrator account for normal operation. It is permissible to require the computer operating system administrator account for initial application installation and configuration.
 - c. 3.3.1.1.1 User Account Levels
 - 1) Configure OT using three account access levels: operator level, service level, and administration level. Configure normal operations to occur using an operator level account. Configure the operator level with minimum privileges required to operate the system that does not allow for configuration changes. Disable removable media devices and USB ports (with the exception of keyboard and mouse) for all levels except the administrator level. Submit an Account Level Permissions List (Encrypted) documenting the names all levels and which permissions are allowed for each level.
6. Controllers
 - a. For user interfaces provided by controllers, provide access control in accordance with the User Interface Requirements table for the applicable control system and user interface type.
 - 1) For table entries of "NA": NA means Not Applicable, there are no interfaces in this category.
 - 2) For table entries of "None Required": The user interface is not required to support user accounts.
 - 3) For table entries of "MINIMALLY": The user interface must at least MINIMALLY support user accounts.
 - 4) For table entries of "FULLY": The user interface must at FULLY support user accounts.
 - 5) For table entries of "KEY": The user interface must have physical security in the form of either a key lock on the interface itself or be furnished inside a lockable enclosure. Where this is required for a read only interface, the lockable enclosure must prevent viewing of data on the interface; for other interfaces, this lockable enclosure must prevent using the interface to alter data.
 - 6) For table entries of "Physical Security": For Local FULL interfaces, the interface must be located inside mission space. For Local Limited (not FULL) interfaces, the user interface must either a) be located within mission space or b) be protected by physical security at least as good as the control devices (and equipment controlled by the control devices) affected by the interface. For purposes of this requirement, 'affected' includes controllers with data that can be directly altered by the interface, as well as mechanical and/or electrical

equipment directly controlled by those controllers, but does not include other interactions.

- 7) Entries of the form "X and Y" must meet both the requirement indicated for X and the requirement indicated for Y. For example, an entry of "MINIMALLY and Physical Security" indicates the user interface must both MINIMALLY support accounts and have physical security.
- 8) Entries of the form "X or Y" must meet either the requirement indicated for X or the requirement indicated for Y.

HVAC Control Systems

User Interface Requirements for LOW Impact HVAC Control Systems

User Interface Type	Access Control Requirement
Local Read Only (see note 1)	None Required
Local Limited, Non-privileged	{CH#10328076}
Local Limited, Privileged	{CH#10328077}
Local Full	MINIMALLY
Remote Read Only	None Required
Remote Limited, Non-Privileged	MINIMALLY
Remote Limited, Privileged AND	FULLY
Remote Full (see note 2)	

Notes:

1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged

User Interface Requirements for MODERATE Impact HVAC Control Systems

User Interface Type	Access Control Requirement
	(See note 3)
Local Read Only (see note 1)	None Required
Local Limited, Non-privileged	{CH#10328078}
Local Limited, Privileged	{CH#10328079}
Local Full	MINIMALLY and Physical Security
Remote Read Only	{CH#10328080}
Remote Limited, Non-Privileged	FULLY
Remote Limited, Privileged AND	FULLY
Remote Full (see note 2)	

Notes:

1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged

3)Devices outside mission space require physical security protections as indicated (in"PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")

Electronic Security Systems (ESS)

User Interface Requirements for LOW Impact Electronic Security Systems

User Interface Type	Access Control Requirement
Local Read Only (see note 1)	{CH#10328086}
Local Limited, Non-privileged	NA

Local Limited, Privileged	{CH#10328087}
Local Full	FULLY and Physical Security
Remote Read Only	{CH#10328088}
Remote Limited, Non-Privileged	NA
Remote Limited, Privileged AND	FULLY
Remote Full (see note 2)	
Notes:	
1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged	
User Interface Requirements for MODERATE Impact Electronic Security Systems	
User Interface Type	Access Control Requirement
	(See note 3)
Local Read Only (see note 1)	{CH#10328089}
Local Limited, Non-privileged	NA
Local Limited, Privileged	FULLY
Local Full	FULLY and Physical Security
Remote Read Only	{CH#10328090}
Remote Limited, Non-Privileged	NA
Remote Limited, Privileged AND	FULLY
Remote Full (see note 2)	
Notes:	
1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged	
3)Devices outside mission space require physical security protections as indicated (in"PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	
Fire Protection Systems	
User Interface Requirements for LOW Impact Fire Protection Systems	
User Interface Type	Access Control Requirement
Local Read Only (see note 1)	None Required
Local Limited, Non-privileged	{CH#10328091}
Local Limited, Privileged	KEY and Physical Security
Local Full	KEY
Remote Read Only	None Required
Remote Limited, Non-Privileged	MINIMALLY
Remote Limited, Privileged AND	FULLY
Remote Full	
Notes:	
1)Local Read Only User Interfaces are always Non-Privileged	
User Interface Requirements for MODERATE Impact Fire Protection Systems	
User Interface Type	Access Control Requirement

Local Read Only	None Required
Local Limited, Non-privileged	{CH#10328092}
Local Limited, Privileged	{CH#10328093}
Local Full	KEY
Remote Read Only	{CH#10328094}
Remote Limited, Non-Privileged	FULLY
Remote Limited, Privileged AND	FULLY
Remote Full	

Notes:

- 1) Local Read Only User Interfaces are always Non-Privileged
- 2) Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")

Control Systems

User Interface Requirements for LOW Impact {CH#10328105} Systems

User Interface Type	Access Control Requirement
Local Read Only (see note 1)	{CH#10328106}
Local Limited, Non-privileged	{CH#10328107}
Local Limited, Privileged	{CH#10328108}
Local Full	{CH#10328109}
Remote Read Only	{CH#10328110}
Remote Limited, Non-Privileged	{CH#10328111}
Remote Limited, Privileged AND	{CH#10328112}
Remote Full (see note 2)	

Notes:

- 1) Local Read Only User Interfaces are always Non-Privileged
- 2) Remote Full User Interfaces are always Privileged

User Interface Requirements for MODERATE Impact {CH#10328113} Systems

User Interface Type	Access Control Requirement
	(See note 3)
Local Read Only	{CH#10328114}
Local Limited, Non-privileged	{CH#10328115}
Local Limited, Privileged	{CH#10328116}
Local Full	{CH#10328117}
Remote Read Only	{CH#10328118}
Remote Limited, Non-Privileged	{CH#10328119}
Remote Limited, Privileged AND	{CH#10328120}
Remote Full (see note 2)	

Default Requirements for Other Control Systems

For control system devices where User Interface Requirements are not otherwise indicated in this Section, use the Default User Interface Requirements tables.

Default User Interface Requirements for LOW Impact Control Systems

User Interface Type	Access Control Requirement
Local Read Only (see note 1)	{CH#10328121}
Local Limited, Non-privileged	{CH#10328122}
Local Limited, Privileged	{CH#10328123}
Local Full	{CH#10328124}
Remote Read Only	{CH#10328125}
Remote Limited, Non-Privileged	MINIMALLY
Remote Limited, Privileged AND	FULLY
Remote Full (see note 2)	
Default User Interface Requirements for LOW Impact Control Systems	
User Interface Type	Access Control Requirement
Notes:	
1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged	
Default User Interface Requirements for MODERATE Impact Control Systems	
User Interface Type	Access Control Requirement
	(See note 3)
Local Read Only (see note 1)	{CH#10328126}
Local Limited, Non-privileged	{CH#10328127}
Local Limited, Privileged	{CH#10328128}
Local Full	{CH#10328129}
Remote Read Only	{CH#10328130}
Remote Limited, Non-Privileged	FULLY
Remote Limited, Privileged AND	FULLY
Remote Full (see note 2)	
Notes:	
1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged	
3)Devices outside mission space require physical security protections as indicated (in"PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	

7. Additional User Account Expiration Requirements In MODERATE Impact Systems:

- a. In addition to other user account requirements, user account expiration and auditing must be configured as indicated.
- b. For Control System Applications Running on Computers
 - 1) If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 35 days of inactivity.
- c. For Other Control System Devices FULLY Supporting Accounts If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 365 days of inactivity.

B. Unsuccessful Logon Attempts

1. {For Government Reference Only: This subpart (and its subparts) relate to AC-7 (a), AC-7 (b); CCI-000043, CCI-000044, CCI-001423, CCI-002236, CCI-002237, CCI-002238}
2. Except for high availability user interfaces indicated as exempt, devices must meet the indicated requirements for handling unsuccessful logon attempts. If a device cannot meet

these requirements, document device capabilities to protect from subsequent logon attempts and propose alternate protections in a Device Account Lock Exception Request submittal. Do not implement alternate protection measures in lieu of the indicated requirements without explicit permission from the Government. If no Device Account Lock Exceptions are requested, provide a document stating that no approval is being requested as the Device Account Lock Exception Request.

3. Devices MINIMALLY Supporting Accounts

- a. For LOW Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts [are not required to lock based on unsuccessful logon attempts][must lock the user account [after [five] consecutive failed login attempts] and must unlock the user account after [15] minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account].
- b. For MODERATE Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts must lock the user account[after [five] consecutive failed login attempts] and must unlock the user account after {CH#10328132} minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account.

4. Devices FULLY Supporting Accounts

- a. Devices which FULLY support accounts must meet the following requirements.
 - 1) It must lock the user account when {CH#10328133} unsuccessful logon attempts occur within a {CH#10328134} interval.
 - 2) Once an account is locked, the account must stay locked until unlocked by an administrator. If the account being locked is the sole administrator account on the device, the account must stay locked for {CH#10328135} and then automatically unlock.
- b. Once the indicated number of unsuccessful logon attempts occurs, delay further logon prompts by 5 seconds.

C. High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements

- a. {CH#10328136} [The following high availability interfaces are exempt from unsuccessful logon attempts requirements:

High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements		
User Interface	Location	Action to take in lieu of locking screen
{CH#10328137}	{CH#10328138}	{CH#10328139}
{CH#10328140}	{CH#10328141}	{CH#10328142}
High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements		
User Interface	Location	Action to take in lieu of locking screen
{CH#10328143}	{CH#10328144}	{CH#10328145}

D. System Use Notification

1. {For Government Reference Only: This subpart (and its subparts) relates to AC-8; CCI-000048, CCI-002247, CCI-002243, CCI-002244, CCI-002245, CCI-002246, CCI-000050, CCI-002248}
2. System Use Notification for Remote User Interfaces
 - a. Remote user interfaces must display a warning banner meeting the requirements of DTM 08-060 on screen.
3. System Use Notification for Local User Interfaces
 - a. Devices which are connected to a network and have a local user interface must display a warning banner meeting the requirements of DTM 08-060 on the user interface screen if capable of doing so and must have a permanently affixed label with an approved banner from DTM 08-060 if unable to display the warning banner on the screen. Where it is impractical (perhaps due to device size) to affix the label to the device, affix the label to the device enclosure.

- b. Labels must be machine printed or engraved, plastic or metal, designed for permanent installation, must use a font no smaller than 14 point, and must provide a high contrast between font and background colors.
- E. Session Lock and Session Termination Requirements In MODERATE Impact Systems:
- 1. {For Government Reference Only: This subpart (and its subparts) relates to AC-11(a), AC-11(b), AC-11(1), AC-12, SC-10; AC-10; CCI-000058, CCI-000059, CCI-000056, CCI-000057, CCI-000060, CCI-002360, CCI-002361, CCI-001133, CCI-001134, CCI-000054, CCI-000055, CCI-002252}
 - 2. Session Termination
 - a. When session termination is required for a User Interface, the User Interface must implement session termination a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.
 - b. Session Termination must result in logging out the user. A logged out User Interface may only perform actions as indicated in the "Permitted Actions Without Identification or Authentication" subpart of this Section or display a publicly viewable image or blank screen. User Interfaces must remain logged out (session terminated) until a user enters correct authentication information, which must initiate a new session. All User Interfaces running on computers and all Remote User Interfaces must also terminate network connections as part of session termination.
 - 3. Session Lock
 - a. When session lock is required for a User Interface, the User Interface must implement session lock a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.
 - b. Session lock must result in the User Interface being suspended and the user interface must display a publicly viewable image or blank screen. No interaction with the user interface must be possible until either a) the same user enters valid authentication information, in which case that session must be continued, or b) until a different user enters valid authentication information at which point the first session must be terminated and a new session initiated for the new user.
 - 4. Session Lock and Termination for Computers
 - a. {CH#10328146} User Interface sessions provided by computer operating systems must support the requirement for both Session Lock and Session Termination. Session Lock and Session Termination must be capable of being initiated by the user and must also be initiated by lack of activity. Session Lock must occur after {CH#10328147} minutes of inactivity, and Session Termination must occur after {CH#10328148} minutes total of inactivity (including, not in addition to, the time for Session Lock). When a user initiates a new session, terminate existing sessions if necessary to limit the total number of concurrent sessions to 1.
 - b. {CH#10328149} Other User Interface sessions running on computers (for local user interfaces) or hosted on a computer (for remote user interfaces) and supporting accounts must support user initiation of Session Termination[and session lock. Session lock may be initiated by user initiation or automatically after [15] minutes of inactivity]. In addition, remote User Interface sessions must also initiate Session Termination after {CH#10328150} minutes of inactivity {CH#10328151}.
 - 5. Session Lock and Termination for Controllers
 - a. {CH#10328152} Writable Remote User Interfaces must support requirements for Session Termination, and must both be capable of being initiated by the user and initiated by lack of activity. Session Termination must initiate after {CH#10328153} minutes of inactivity.
 - b. {CH#10328154} Local User Interfaces supporting accounts must support manual initiation of Session Termination. Privileged Local User Interfaces must also support timed initiation of Session Termination {CH#10328155}, with Session Termination initiated at {CH#10328156} minutes of inactivity. [They must also support session lock, where session lock may be initiated by user initiation or automatically after [15] minutes of inactivity.]

Session Lock and Termination Exceptions

Table: Session Lock and Termination Exceptions

Device	Location	Session Lock and Termination Requirements for Device (or "none" to indicate session lock or session termination is not required)
{CH#10328157}	{CH#10328158}	{CH#10328159}
{CH#10328160}	{CH#10328161}	{CH#10328162}
{CH#10328163}	{CH#10328164}	{CH#10328165}

- F. Permitted Actions Without Identification or Authentication
- {For Government Reference Only: This subpart (and its subparts) relates to AC-14; CCI-000061, CCI-000232}
 - The control system must require identification and authentication before allowing any actions {CH#10328166} by a user acting from a user interface which MINIMALLY or FULLY supports accounts.
- G. Physical Security in MODERATE Impact Systems
- {For Government Reference Only: This subpart relates to PE-3(1), PE-4, PE-5, SC-7(a), SC-7(c), SC-8, SC-8(1); CCI-000928, CCI-002926, CCI-000936, CCI-002930, CCI-002931, CCI-000937, CCI-001097, CCI-001109, CCI-002418, CCI-002419, CCI-002421.}
 - Physical Security for Media
 - Physical Security for Media Inside Mission Space
 - Install all non-IP network media located inside of the mission space in conduit. Install all IP network media located inside of the mission space in intermediate metallic conduit.
 - Physical Security for Media Outside Mission Space
 - Install all network media (both IP and non-IP) located outside of the mission space in rigid metallic conduit.
 - Physical Security for Non-Network Media in Fire Protection Systems
 - For Fire Suppression Systems which can be inhibited or forced to activate by manipulation of non-network wiring, install all non-network media outside of mission space, including analog and binary instrumentation wiring and power wiring, in rigid metallic conduit.
 - Physical Security for Devices
 - Install all devices (computers and controllers) which are located outside of mission space in lockable enclosures. (Recall that per definition of mission space, a room controlled by the mission is mission space regardless of whether it is contiguous with other mission space.)
 - Install all controllers, and other OT devices, connected to an IP network in lockable enclosures (both inside and outside of mission space).
 - Physical Security for Devices in Fire Protection Systems
 - For Fire Suppression systems with a release panel, install all components of the suppression system either inside mission space, or within locked enclosures. Components of these systems include: release panel, any relay or interface panels, analog and binary inputs or outputs, control valves, manual valves.
 - Physical Security for User Interfaces
 - Physical security requirements for User Interfaces are specified in the preceding paragraphs of this Section.
- H. Additional Physical Security for Confidentiality of User Interfaces and Printers
- For each user interface or printer indicated in the "User Interfaces and Printers Requiring Additional Security Controls" table, implement the additional confidentiality controls indicated.

User Interfaces and Printers Requiring Additional Security Controls

User Interface or Printer	Location	Additional Confidentially Control to be Implemented
{CH#10328167}	{CH#10328168}	{CH#10328169}
{CH#10328170}	{CH#10328171}	{CH#10328172}
{CH#10328173}	{CH#10328174}	{CH#10328175}

I. Enclosures

1. Prior to final acceptance of the system, lock all lockable enclosures. Submit an Enclosure Keys submittal with all copies of keys for all enclosures and a key inventory list documenting all keys. Label each key with the matching enclosure identifier.

3.04 USER IDENTIFICATION AND AUTHENTICATION

- A. {For Government Reference Only: This subpart (and its subparts) relates to IA-2, IA-2(1), IA-2(12), IA-5 IA-5(b), IA-5(c), IA-5(e), IA-5(g), IA-5(1), IA-5(11); CCI-000764, CCI-000765, CCI-001953, CCI-001954, CCI-001544, CCI-001989, CCI-000182, CCI-001610, CCI-000192, CCI-000193, CCI-000194, CCI-000205, CCI-001619, CCI-001611, CCI-001612, CCI-001613, CCI-001614, CCI-000195, CCI-001615, CCI-000196, CCI-000197, CCI-000199, CCI-000198, CCI-001616, CCI-001617, CCI-000200, CCI-001618, CCI-002041, CCI-002002, CCI-002003.
- B. For MODERATE Impact systems, this subpart also relates to AC-6 (1), AC-6(10), AC-6(2), AC-6(9)-IA-2(4), IA-5(13); CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-000768, CCI-002007.}
- C. This subpart indicates requirements for specific methods of identification and authentication for users and user accounts. Where these requirements conflict apply the following order of precedence: 1) If present, Device Specific Requirements take precedence over any other requirements; and then 2) multifactor authentication requirements take precedence over password requirements.
- D. User Identification and Authentication for All System Types
 1. Unless otherwise indicated, all user interfaces supporting accounts (either FULLY or MINIMALLY) must implement Identification and Authorization via passwords.
 2. For LOW Impact Systems: User interfaces provided by computer operating systems must implement multifactor authentication via PIV.
 3. For MODERATE Impact Systems:[User interfaces provided by computer operating systems must implement multifactor authentication via PIV.] User interfaces supporting accounts (FULLY or MINIMALLY) on computers must implement multifactor authentication via PIV. Software running on computers and computer operating systems must manage cached authenticators in accordance with the relevant STIGs. All other devices and software must not use cached authenticators.
- E. User Identification and Authentication for Specific System Types
 1. System specific requirements are in addition to and supersede those indicated for all system types. When no additional requirements are indicated for a specific system type the requirements for all systems still apply to that system type.
 2. HVAC Control Systems Devices
 - a. {CH#10328177}
 3. Lighting Control Systems Devices
 - a. {CH#10328178}
 4. Electronic Security System Devices
 - a. User interfaces which FULLY support accounts and which run on a computer must use multifactor authentication via PIV. {CH#10328179}
 5. Control System Devices
- F. User Identification and Authentication for Specific Devices
 1. {CH#10328180} [Additional user identification and authentication requirements are defined in the TABLE.

TABLE: Additional Device Specific User Identification and Authentication Requirements

User Interface Device or Description	Identification and Authorization Requirements
{CH#10328181}	{CH#10328182}
{CH#10328183}	{CH#10328184}
{CH#10328185}	{CH#10328186}
{CH#10328187}	{CH#10328188}

G. Implementation of Identification and Authorization Requirements

1. Identification and Authorization must be met by one of the following methods:
 - a. Direct implementation in the user interface.
 - b. For user interfaces on a computer: inheriting the Identification and Authorization from the computer operating system, either by the operating system limiting access to specific applications by user, or by the application itself having permissions based on the user logged into the computer.
 - c. For remote interfaces: an implementation shared between the remote user interface server and the remote user interface client. For example, a requirement for PIV authentication may be met on a remote user interface by a PIV reader on a web browser client which sends the authentication information via HTTPS to the remote server.

H. Password-Based Authentication Requirements

1. Passwords for Software and Applications Running on Computers
 - a. All software and applications running on computers supporting
 - 1) password-based authentication must enforce the following requirements:
 - 2) Minimum password length of 12 characters
 - 3) Password must contain at least one uppercase character.
 - 4) Password must contain at least one lowercase character.
 - 5) Password must contain at least one numeric character.
 - 6) Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.
 - 7) Password must have a minimum lifetime of 24 hours.
 - 8) Password must have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.
 - 9) Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).
 - 10) Passwords must be cryptographically protected during storage and transmission.
2. Passwords for Controllers FULLY Supporting Accounts
 - a. All controllers FULLY supporting accounts and supporting password-based authentication must enforce the following requirements:
 - 1) Minimum password length of 12 characters
 - 2) Password must contain at least one uppercase character.
 - 3) Password must contain at least one lowercase character.
 - 4) Password must contain at least one numeric character.
 - 5) Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.
 - 6) Password must have a maximum lifetime of sixty (60) days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.
 - 7) Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters.

- 8) Passwords must be cryptographically protected during storage and transmission.
3. Passwords for Remote Interfaces
 - a. Passwords for connecting to a Remote User Interface supporting password-based authentication must enforce the following requirements:
 - 1) Minimum password length of 12 characters
 - 2) Password must contain at least one uppercase character.
 - 3) Password must contain at least one lowercase character.
 - 4) Password must contain at least one numeric character.
 - b. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.
 - 1) Password must have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.
 - 2) Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).
 - 3) Passwords must be cryptographically protected during storage and transmission.
4. Passwords for Devices Minimally Supporting Accounts
 - a. Devices MINIMALLY supporting accounts must support passwords with a minimum length of {CH#10328189} characters.
5. Password Configuration and Reporting
 - a. For all devices with a password, change the password from the default password. Coordinate selection of passwords with the Password Point of Contact. Do not use the same password for more than one device unless specifically instructed to do so. Provide a Confidential Password Report documenting the password for each device and describing the procedure to change the password for each device.
 - b. Do not provide the Password Summary Report in electronic format. Provide {CH#10328190} hardcopies of the Password Summary Report, each copy in its own sealed envelope.
 - c. For all devices with a password, coordinate the changing of passwords with the project site following testing of the system but prior to turnover to the Government.
 - d. Coordinate with Password Point of Contact to determine appropriate project site personnel to complete password changes.
 - e. Accompany identified personnel to each device with a password and instruct personnel on the process of changing password. Record the time, date and personnel present when each device's password is changed and submit a Password Change Summary Report documenting this information.
 - f. Provide the Password Summary Report electronically in both PDF and Microsoft Excel.
- I. Authenticator Feedback
 1. {For Government Reference Only: This subpart relates to IA-6; CCI-000206}
 2. Devices must never show authentication information, including passwords, on a display. Devices that momentarily display a character as it is entered, and then obscure the character, are acceptable. For devices that have STIGs or SRGs related to obscuring of authenticator feedback (CCI-000206), comply with the requirements of those STIGS/SRGs.

3.05 CYBERSECURITY AUDITING

- A. Where an auditing requirement exists for email notification, notify via email the application administrator and Information System Security Officer (ISSO) of the event. Coordinate with the Email Address Point of Contact for email addresses. If outgoing email is not available to the system, disable email notifications.]

B. Audit Events, Content of Audit Records, and Audit Generation

1. {For Government Reference Only: This subpart (and its subparts) relates to AU-2(a), AU-2(c), AU-2(d), AU-3, AU-10, AU-12, AU-14(b), AU-14(1), AU-14(2), AU-14(3), CM-5(1), SC-7 (9); CCI-000123, CCI-001571, CCI-000125, CCI-001485, CCI-000130, CCI-000131, CCI-000132, CCI-001230, CCI-000133, CCI-000134, CCI-001487, CCI-000166, CCI-001899, CCI-000169, CCI-001459, CCI-000171, CCI-000172, CCI-001910, CCI-001914, CCI-001919, CCI-001464, CCI-001462, CCI-001920, CCI-001814, CCI-002400.
2. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-3 (1); CCI-000135, CCI-001488}
3. For devices that have STIG/SRGs related to audit events, content of audit records or audit generation, comply with the requirements of those STIG/SRGs.
4. If auditing requirements can be met using existing control system alarm or event capabilities, those existing capabilities may be used to meet these requirements.
5. Computers
 - a. For each computer, provide the capability to select audited events and the content of audit logs. Configure computers to audit the indicated events, and to record the indicated information for each auditable event. Send logs to a syslog server that is only accessible via accounts on the system with privileged level access.
 - b. Audited Events
 - 1) Configure each computer to audit the following events:
 - (a) Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)
 - (b) Successful and unsuccessful logon attempts
 - (c) Successful logouts
 - (d) Privileged activities or other system level access
 - (e) Concurrent logons from different workstations
 - 2) Successful and unsuccessful accesses to objects
 - (a) Program initiations
 - (b) Direct access to the information system
 - (c) Account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.
 - (d) Kernel module load, unload, and restart
 - 3) Operator actions related to operation of the system
 - c. Audit Event Information To Record
 - 1) Configure each computer to record, for each auditable event, the following information (where applicable to the event):
 - (a) What type of event occurred
 - (b) When the event occurred
 - (c) Where the event occurred
 - (d) The source of the event
 - (e) The outcome of the event
 - (f) The identity of any individuals or subjects associated with the event
 - (g) For MODERATE Impact Systems: For all privileged commands, full-text recording of the executed command and the user executing the command
 - d. For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation.
6. For HVAC Control System Controllers
 - a. HVAC Control System Controllers FULLY Supporting User Accounts
 - 1) For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit

the indicated events, and to record the indicated information for each auditable event.

2) Audited Events

(a) Configure each controller to audit the following events:

- (1) Successful and unsuccessful logon attempts to the controller
- (2) Successful logouts
- (3) All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.
- (4) All controller shutdown and startup
- (5) For privileged user interfaces in MODERATE Impact Systems: All user commands.

3) Audit Event Information To Record

(a) Configure each controller to record, for each auditable event, the following information (where applicable to the event):

- (1) what type of event occurred
- (2) when the event occurred
- (3) the identity of any individuals or subjects associated with the event
- (4) For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.

(b) For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation.

b. Other HVAC Control System Controllers

- 1) There are no requirements to perform auditing at HVAC field controllers that do not FULLY support accounts.

7. Control System Controllers

8. Default Requirements for Control System Controllers

a. For control system controllers where Audit Events, Content of Audit Records, and Audit Generation are not otherwise indicated in this Section:

b. Controllers Which FULLY Support Accounts

- 1) For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

(a) Audited Events

(b) Configure each controller to audit the following events:

- (1) Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)
- (2) Successful and unsuccessful logon attempts
- (3) Successful logouts
- (4) Concurrent logons from different workstations
- (5) All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.
- (6) All kernel module load, unload, and restart
- (7) For privileged user interfaces in MODERATE Impact Systems: All user commands.

2) Audit Event Information To Record

(a) Configure each controller to record, for each auditable event, the following information (where applicable to the event):

- (1) what type of event occurred

- (2) when the event occurred
 - (3) where the event occurred
 - (4) the source of the event
 - (5) the outcome of the event
 - (b) the identity of any individuals or subjects associated with the event
 - (1) For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.
 - (c) For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation
- c. Controllers Which Do Not FULLY Support Accounts
 - 1) For each controller which does not FULLY support accounts configure the controller to audit all controller shutdown and startup events and to record for each event the type of event and when the event occurred.
- C. Audit Time Stamps
 - 1. {For Government Reference Only: This subpart (and its subparts) relates to AU-8; CCI-000159, CCI-001889, CCI-001890.
 - 2. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-8 (1); CCI-001891, CCI-001892, CCI-002046.}
 - 3. Any device (computer or controller) generating audit records must have an internal clock capable of providing time with a resolution of one second. Clocks must not drift more than 10 seconds per day. Configure the system so that each device (computer or controller) generating audit records maintains accurate time to within 1 second. Note that if the control system specifications include requirement for clocks, the most stringent requirement applies.
- D. Auditing Front End Software
 - 1. The project site currently has the following software to support control system auditing: {CH#10328192}. If there is no existing auditing front end software or the software is not compatible with the provided control systems, provide Auditing Front End Software with audit log import and upload, export, notification, and analysis functionality. The Auditing Front End Software may be provided as a component of the control system front end or as a separate software package, and a single package may serve multiple control systems provided under the same projects if they are sharing a cybersecurity authorization.
 - 2. When the Auditing Front End Software is neither existing nor installed under the requirements of another Section, furnish the Auditing Front End Software media and license {CH#10328193}.
 - 3. Submit copies of Auditing Front End Software if this function is not part of the software provided with the control system to meet requirements of other Sections.
- E. Import and Upload Requirements
 - 1. Auditing Front End Software must be capable of importing audit logs from the Device Audit Record Upload Software and of uploading audit logs over the network from all control system devices supporting network upload of audit logs.
- F. Export Requirements
 - 1. Auditing Front End Software must be capable of exporting to a file format supported by Microsoft Excel.
- G. Notification Of Audit Failure in Devices in MODERATE Impact Systems
 - 1. The auditing front end software must be capable of receiving notifications of audit failure from control system devices and computers and be able to provide email notification based on receipt of the notification.
- H. Audit Reduction and Report Generation In MODERATE Impact Systems

1. {For Government Reference Only: This subpart (and its subparts) relates to AU-6(4), AU-7(a), AU-7(b), AU-7(1), AU-12(1); CCI-000154, CCI-001875, CCI-001876, CCI-001877, CCI-001878, CCI-001879, CCI-001880, CCI-001881, CCI-001882, CCI-000158, CCI-000173, CCI-000174, CCI-001577.}
 2. Auditing Front End Software must provide audit reduction and reporting capabilities that supports on-demand review and analysis, on demand reporting, and after the fact investigations of security incidents. The software must be able to combine audit records from all components within the system and analyze them as a single audit record. The software must correct for discrepancies in timestamps of audit logs from different sources and be able to account for discrepancies up to {CH#10328194} seconds between sources. The software must not alter original audit record content or time ordering of audit records. The software must have the capability to filter audit records using user-defined fields within the audit records.
 3. The audit reduction and reporting capabilities may incorporate third party application, such as Excel or Access.
- I. Audit Storage Capacity and Audit Upload
1. {For Government Reference Only: This subpart (and its subparts) relates to AU-4; CCI-001848, CCI-001849}
 2. The creation of audit records must never interfere with normal device operation. Devices must cease collection of auditing information if required to maintain normal operation.
 - a. For devices that have STIG/SRGs related to audit storage capacity (CCI-001848 or CCI-001849) comply with the requirements of those STIG/SRGs.
 - b. For controllers capable of generating audit records, provide 60 days worth of secure local storage, assuming 10 auditable events per day.
 - c. For computers, provide storage for at least {CH#10328197} audit records.
 3. Audit Log Storage Notification In MODERATE Impact Systems
 - a. {For Government Reference Only: This subpart (and its subparts) relates to AU-5(1); CCI-001855.}
 - b. Controllers storing audit logs must provide notification when audit logs reach 75 percent of capacity either directly through email or indirectly by sending a notification to a computer, and the computer sending an email. Computers storing audit logs must provide notification when audit logs reach 75 percent of capacity directly through email.
 4. Device Audit Record Upload Software
 - a. For each device (computer or controller) required to audit events and for which audit logs cannot be uploaded over the network by the Auditing Front End Software, provide and license to the Government software implementing a secure mechanism of uploading audit records from the device and exporting them to the Auditing Front End Software. Where different devices use different software, provide software of each type required to upload audit logs from all devices.
 - b. {CH#10328198} Submit copies of device audit record upload software if this function is not part of the software provided with the control system to meet requirements of other Sections. If there are no devices requiring this software, provide a document stating this in lieu of this submittal.
- J. Response to Audit Processing Failures
1. {For Government Reference Only: This subpart (and its subparts) relates to AU-5; CCI-000139, CCI-000140, CCI-001490.}
 2. In the case of a failure in the auditing system, computers associated with auditing must provide email notification {CH#10328199}. For MODERATE Impact systems, the computer must also notify the associated auditing front end software. In case of an audit failure, if possible, continue to collect audit records by {CH#10328200}.
 3. For MODERATE Impact Systems: In the case of an audit failure at a controller performing auditing, the device must notify the associated auditing front end software of the audit failure if able, and must continue to collect audit records by {CH#10328201} if able. The

auditing front end software must provide notification as indicated, treating the notification of failure from the device as a failure in the auditing system.

3.06 REQUIREMENTS FOR LEAST FUNCTIONALITY

- A. {For Government Reference Only: This subpart (and its subparts), along with the Network Communication, Ports, Protocols and Services Report submittal specified elsewhere in this section, relates to CM-6(a), CM-6(c), CM-7, CM-7(1)(b), SC-41; CCI-000363, CCI-000364, CCI-000365, CCI-001588, CCI-001755, CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546.
- B. For MODERATE Impact systems, this subpart (and its subparts) also relates to CM-7(2), CM-7(5)(a), CM-7(5)(b); CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762}
- C. For devices that have a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port and device I/O access for least functionality), install and configure the device in accordance with that STIG or SRGs.
- D. Device Capabilities
 - 1. For HVAC Control Systems: Do not provide devices with remote user interfaces or with full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.
 - 2. For Lighting Control Systems: Do not provide devices with remote user interfaces or with full user interfaces where one was not required.
 - 3. For Other Control Systems: For LOW Impact Systems: {CH#10328202} [Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.]
 - 4. For Other Control Systems: For MODERATE Impact Systems: Do not provide devices with remote user interfaces or full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.
 - 5. For all MODERATE Impact Systems: Unless specifically required by the government, do not provide a capability to update device firmware over the network.
- E. Software
 - 1. For software that has a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port access for least functionality), install and configure the software in accordance with that STIG or SRG.
 - 2. Do not install software that is not specifically required to meet a contract requirement. Remove any previously installed that is not specifically required to meet a contract requirement. Do not implement functionality within software
- F. that is not specifically required to meet contract requirements.

3.07 SYSTEM AND COMMUNICATION PROTECTION

- A. Collaborative Computing
 - 1. {For Government Reference Only: This subpart relates to SC-15(a), SC-15(b); CCI-001150, CCI-001152.}
 - 2. Without explicit approval from the project site, control systems must not use collaborative computing technologies.
- B. Denial of Service Protection and Application Partitioning In MODERATE Impact Systems:
 - 1. {For Government Reference Only: This subpart relates to SC-5, SC-12, SC-7(a); CCI-001093, CCI-002385, CCI-002386, CCI-002430, CCI-001097.
 - 2. For MODERATE Impact systems, this subpart also relates to SC-2; CCI-001082.}
 - 3. To the greatest extent practical, implement control logic without reliance on the network. Except when required to meet the requirements of the control system Section (where the requirement can only be met using computer hardware), do not implement control logic in computers. For MODERATE Impact systems, do not implement control logic in a device providing (i.e. acting as a server for) a Full Remote User Interface.
 - 4. Network Reliance in MODERATE Impact HVAC Control Systems

- a. Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.
 - b. Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.
5. Network Reliance in MODERATE Impact Lighting Control Systems
 - a. Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.
 - b. Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.
6. Network Reliance in MODERATE Impact Control Systems
7. Default Requirements for MODERATE Impact Control Systems
 - a. Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.
 - b. Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.
- C. Mobile Code In MODERATE Impact Systems:
 1. {For Government Reference Only: This subpart relates to SC-18(a), SC-18(b), SC-18(c), SC-18(1), SC-18(3), SC-18(4); CCI-001160, CCI-001161, CCI-001162, CCI-001163, CCI-001164, CCI-001165, CCI-001166, CCI-001662, CCI-002457, CCI-002458, CCI-001169, CCI-001695, CCI-001170, CCI-002469}
 2. Devices with STIGs/SRGs related to Mobile Code and to Security Control SC-18 must be installed in accordance with the relevant STIGs/SRGs. All remote user interfaces must meet the requirements of the "Web Browsers and Application SRG".
 3. {CH#10328203}
- D. Protection of Information at Rest In MODERATE Impact Systems:
 1. {For Government Reference Only: This subpart relates to SC-28, SC-28(1); CCI-001199, CCI-002472, CCI-002475, CCI-002476}
 2. Computers must protect information at rest in accordance with applicable STIGs.
 3. Any control system device storing personally identifiable information (PII), controlled unclassified information (CUI), or classified information must be protected by an Information At Rest encryption solution or by a physical security solution. Provide a Protection of Information At Rest Proposal indicating each device storing PII, CUI, or classified information and the encryption or physical security solution proposed for that device for government approval. If no devices stores PII, CUI, or classified information, provide a document stating this as the Protection of Information At Rest Proposal submittal. Do proceed with device selection and installation until the Protection of Information At Rest Proposal is approved. Once approved, implement approved Information At Rest protections.
- E. Process Isolation and Boundary Protection in Moderate Impact Fire Protection Systems
 1. {For Government Reference Only: This subpart relates to SC-7(a), SC-7(c), SC-7(4)(a), SC-7(4)(c), SC-7(5), SC-7(7), SC-7(9)(a), SC-7(11), SC-7(13), SC-7(13), SC-7(18); CCI-001097, CCI-001098, CCI-001102, CCI-002396, CCI-001109, CCI-002397, CCI-002398, CCI-002399, CCI-002403, CCI-001120, CCI-001119, CCI-001126}
 2. Radio Interfaces for Fire Protection Systems

- a. When radios interfacing a local fire protection system to a supervisory system are not NIST FIPS 140-2 validated, use a relay panel interface between the local fire protection system and the radio. Install and configure the relay panel to prohibit initiating any action within the local fire protection system other than causing the system to play a pre-recorded message[or causing the system to play a live audio message]. Install relays using the normally open contact such that they pass a signal when they close, and so that a relay that loses power or has a failed coil does not pass a signal
- F. Fire Suppression System Network Isolation
 - 1. For fire suppression systems including a release panel, any network used in these systems must be dedicated to these systems and must be isolated from any other network, including other components of the Fire Alarm and Fire Suppression systems. Use only dry contacts and relays to transfer signals from these systems to any other systems. {CH#10328205}
- G. Application Separation
 - 1. Configure operating systems, applications, and network accessible devices using application separation. Utilize the operating system on the primary partition of the hard drive. Install application databases on a different partition than the operating system. Install web servers on a different partition than the operating system. Do not install web servers and database servers on the same computer. Do not host web servers and database servers on the same Virtual Machine.

3.08 SAFE MODE AND FAIL SAFE OPERATION

- A. {For Government Reference Only: This subpart (and its subparts) relates to CP-12, SI-10(3), SI-17; CCI-002855, CCI-002856, CCI-002857, CCI-002754, CCI-002773, CCI-002774, CCI-002775}
- B. For all control system components with an applicable STIG or SRG, configure the component in accordance with all applicable STIGs and SRGs.

3.09 SYSTEM MAINTENANCE TOOL SOFTWARE

- A. {For Government Reference Only: This subpart (and its subparts) relates to MA-3; CCI-000865.}
- B. Submit and license to the Government all software required to operate, maintain and modify the control system such the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system, including programming of devices, without subsequent or future dependence on the Contractor, Vendor or Manufacturer. Submit hard copies of user manuals for each software with the software submittal. Provide any hardware keys or dongles, software keys, license numbers, and other information required to enable the Government to access or change the system.
- C. For software provided and licensed to the Government under the requirements of another Section, submit a statement indicating the Section and Submittal under which the software was provided. For software provided to meet the requirements of this Section and not provided and licensed under another Section, submit software and software user manuals on DVD or CD as a Technical Data Package and submit [one hard copy] _ hard copies of the software user manual for each piece of software.

3.10 DEVICE POWER

- A. {For Government Reference Only: This subpart (and its subparts) relates to PE-11, PE-11(1); CCI-002955, CCI-000961. For MODERATE Impact systems,
- B. For LOW Impact Systems: {CH#10328207}
- C. For MODERATE Impact Systems: Provide control system with power supply meeting or exceeding the reliability of the controlled equipment.

- D. Powering control system devices using the same power source as the equipment controlled by the device is a permissible method of meeting this requirement.
- E. Without explicit approval from the government, do not install local uninterruptible power supplies (UPSes) as a source of device power.
- F. Device Behavior on Loss of Power In MODERATE Impact Systems:
 - 1. Application programs and configuration settings must be stored in devices in manner such that a loss of power does not result in a loss of the application program or configuration settings: Loss of power must never result in the loss of application programs, regardless of the length of time power is lost; and loss of power for less than 2,500 hours must not result in the loss of configured settings.
 - 2. In the event of a loss of power, when power is restored, controllers and computers executing control logic (and the underlying equipment) must recover and resume their normal sequences of operation. Note that the sequence of operation may require specific actions (e.g. startup sequences) upon recovery from loss of power.

3.11 VULNERABILITY SCANNING

- A. {For Government Reference Only: This subpart (and its subparts) relates to RA-5 RA-5(a),RA-5(b),RA-5(c),RA-5(d); CCI-001054, CCI-001055, CCI-000156, CCI-001641, CCI-001643, CCI-001057, CCI-001058, CCI-001059.
- B. For MODERATE Impact systems, this subpart (and its subparts) also relates to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906.}
- C. All IP devices must be scannable, such that the device can be scanned by industry standard IP network scanning utilities without harm to the device, application, or functionality.
- D. Computers and Software Running on Computers
 - 1. Computers and applications running on computers must meet relevant vulnerability scanning STIGs/SRGs and respond to approved DoD vulnerability scanning tools.
- E. Controllers
 - 1. Provide controllers that are scannable by standard control system discovery tools or control system browsers and return meaningful status information including the network inputs and outputs for the controller. This information must contain sufficient detail to detect vulnerabilities or exploits of the controller.
 - 2. Provide all software needed to scan the control system as the Control System Scanning Tools submittal. If the software required to scan the system is already installed at the project site or is provided under a separate section instead provide a statement indicating this.

3.12 VULNERABILITY ALERTS

- A. Prior to installation, adhere to all vendor-specific and CISA Information Assurance Vulnerability Alert (IAVA, see <https://www.cisa.gov/uscert/ncas/alerts>) requirements for reporting, patching, and/or mitigating. For alerts which occur after installation but before government acceptance:
 - 1. Notify the Contracting Officer within 48 hours of receipt of the alert and within 48 hours of resolution of vulnerabilities.
 - 2. Resolve the vulnerabilities within 30 days of the alert.
 - 3. Submit a Vulnerability Resolution Report within 14 days of

3.13 FIPS 201-2 REQUIREMENT

- A. {For Government Reference Only: This subpart (and its subparts) relates to SA-4 (10); CCI-003116}
- B. Devices in the following systems which implement PIV must be on the NIST FIPS 201-2 approved product list ([https://www.idmanagement.gov/ approved-products-list/](https://www.idmanagement.gov/approved-products-list/)): NONE.

3.14 BIOS/UEFI PROTECTION

- A. Provide a protection mechanism to prevent unwanted changes to the system BIOS/UEFI for all devices on the system, where technically feasible. BIOS/UEFI Protection Mechanisms must

utilize passwords or passphrases that conform to DoD STIG requirements. BIOS/UEFI Protection passwords must be used to allow access by system engineering and administrative personnel after initial commissioning of the system. Enable UEFI Secure Boot if hardware and Operating System support the option. Provide a BIOS/UEFI Protection Password/Passphrase List (Encrypted) documenting all passwords and passphrases.

3.15 SYSTEM AND INTEGRATION INTEGRITY

- A. Malicious Code Protection
 - 1. {For Government Reference Only: This subpart (and its subparts) relates to SI-3(c); CCI-001241, CCI-002623}
 - 2. For all computers installed under this project, provide malware protection software media, provide licenses, and install and configure malware protection software as indicated. Provide the most up-to-date DoD approved software with up-to-date signatures. Verify that the software does not negatively affect the operation of the OT system. Computers being installed must be configured with up-to-date signatures, not older than 10 days, prior to deployment. Submit Antivirus/Antimalware Scan Results to show evidence of a clean scan. Coordinate with the Government Computer Access Point of Contact as required.
 - a. {CH#10328209}
 - b. {CH#10328210}
 - c. {CH#10328211}
- B. Software, Firmware, and Information Integrity In MODERATE Impact Systems:
 - 1. {For Government Reference Only: This subpart relates to CM-5(3); CCI-001749, CCI-002704, CCI-002726}
 - 2. If there exists Integrity Verification Software that can check boot process, software, firmware, or information in the control system and verify its integrity, provide it. If no such software exists, provide a statement to this affect in lieu of the software.
 - 3. {CH#10328212}
- C. Information System Monitoring
 - 1. {For Government Reference Only: This subpart relates to SI-4 (a),(b); CCI-001253, CCI-002645}

3.16 CONTROL SYSTEM CYBERSECURITY TESTING

- A. {For Government Reference Only: For MODERATE Impact systems, this subpart (and its subparts) relates to SA-11(a), SA-11(b), SA-11(c), SA-11(d), SA-11(e); CCI-003171, CCI-003172, CCI-003173, CCI-003174, CCI-003175, CCI-003176, CCI-003177, CCI-003178.}
- B. Control System Cybersecurity Testing Procedures
 - 1. Prepare and submit Control System Cybersecurity Testing Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system meets the requirements of this Section. The Control System Cybersecurity Testing Procedures may be submitted as a Technical Data Package.
- C. Control System Cybersecurity Testing Execution
 - 1. Using the Control System Cybersecurity Testing Procedures verify that the control system meets the requirements of this Section. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. If testing reveals deficiencies in the system, correct the deficiency and retest until successful.
- D. Control System Cybersecurity Testing Report
 - 1. Prepare and submit a Control System Cybersecurity Testing Report documenting all tests performed and their results. Include all tests in the Control System Cybersecurity Testing Procedures and any additional tests performed during testing. Document test failures and repairs conducted with the test results. The Control System Cybersecurity Testing Report may be submitted as a Technical Data Package

3.17 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT

- A. In addition to testing and testing support required by other Sections, provide a minimum of ____ hours of technical support for cybersecurity testing of control systems to support the DoD Risk Management Framework process Cybersecurity assessment of the control system. This support is independent of (and in addition to) the Control System Cybersecurity Testing specified in this section.

3.18 CYBERSECURITY TRAINING

- A. Provide {CH#10328213} hours of classroom {CH#10328214} training for {CH#10328215} Government personnel on the cybersecurity operation and maintenance of the control system provided. This training is in addition to and must be coordinated with control system training specified in other Sections.
- B. The Government will provide the training location. Training must cover, at a minimum: (a) applying software and firmware updates, (b) user account creation, modification and deletion, (c) audit log upload procedures and (d) identification of privileged user interfaces and system impact of those interfaces. Training session must include a question and answer period during which government staff questions about cybersecurity aspects of the control system are answered.

END OF SECTION

SECTION 26 05 05
SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Electrical demolition.

1.02 RELATED REQUIREMENTS

- A. Section 01 70 00 - Execution and Closeout Requirements: Additional requirements for alterations work.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS**2.01 MATERIALS AND EQUIPMENT**

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that abandoned wiring and equipment serve only abandoned facilities.
- B. Report discrepancies to Government before disturbing existing installation.
- C. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Government at least 24 hours before partially or completely disabling system.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring to source of supply.
- D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- F. Repair adjacent construction and finishes damaged during demolition and extension work.
- G. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

3.04 CLEANING AND REPAIR

- A. See Section 01 74 19 - Construction Waste Management and Disposal for additional requirements.
- B. Clean and repair existing materials and equipment that remain or that are to be reused.
- C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

END OF SECTION

**SECTION 26 05 13
MEDIUM-VOLTAGE CABLES**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Medium voltage cable.
- B. Cable accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 53 - Identification for Electrical Systems.
- B. Section 33 71 19 - Electrical Underground Ducts, Ductbanks, and Manholes: Cable racks in manholes.

1.03 REFERENCE STANDARDS

- A. IEEE C2 - National Electrical Safety Code.
- B. IEEE 48 - IEEE Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV.
- C. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
- D. NEMA WC 71 - Nonshielded Cables Rated 2001-5000 V for Use in the Distribution of Electric Energy.
- E. NEMA WC 74 - 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
- F. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- G. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for cable, terminations, and accessories.
- C. Sustainable Design Documentation: Submit manufacturer's product data on conductor and cable showing compliance with specified lead content requirements.

1.05 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

PART 2 PRODUCTS**2.01 MEDIUM-VOLTAGE CABLE**

- A. Manufacturers:
 - 1. General Cable Technologies Corporation: www.generalcable.com/#sle.
 - 2. Okonite: www.okonite.com/#sle.
 - 3. Southwire Company: www.southwire.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Medium Voltage Cable: NEMA WC 70 rubber insulated cable.
 - 1. Voltage: 15 kV, grounded.
 - 2. Conductor: Copper, compact round, stranded, with foil conductor shield.
 - 3. Construction: Single conductor with metal wire insulation shielding.
 - 4. Insulation Jacket: PVC, 5 mils minimum thickness.

2.02 CABLE ACCESSORIES

- A. Manufacturers:
 - 1. 3M: www.3m.com/#sle.
 - 2. TE Connectivity; Raychem Products: www.te.com/#sle.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Tape Terminations: IEEE 48; Class 1, tape termination kit with semi- conductive tape, stress control tape, splicing tape, vinyl plastic tape, stress cone, mechanical ground straps, and cable preparation kit.
 - 1. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that conduit, duct, trench, or manholes are ready to receive cable.
- B. Verify routing and termination locations of cable bank prior to rough-in.
- C. Cable routing is shown in approximate locations unless dimensioned. Route as required to complete wiring system.

3.02 PREPARATION

- A. Use swab to clean conduits before pulling cables.

3.03 INSTALLATION

- A. Avoid abrasion and other damage to cables during installation.
- B. Use suitable lubricants and pulling equipment.
- C. Sustain cable pulling tensions and bending radii below recommended limits.
- D. Ground cable shield at each termination and splice.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect exposed cable sections for physical damage.
- C. Inspect cable for proper connections as indicated.
- D. Inspect shield grounding, cable supports, and terminations for proper installation.
- E. Inspect and test in accordance with NETA ATS, except Section 4.
- F. Perform inspections and tests listed in NETA ATS, Section 7.3.3. The cable time domain reflectometer (TDR) measurements on each conductor listed as optional are not required.

3.05 PROTECTION

- A. Protect installed cables from entrance of moisture.

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Single conductor building wire.
- B. Nonmetallic-sheathed cable.
- C. Underground feeder and branch-circuit cable.
- D. Service entrance cable.
- E. Armored cable.
- F. Metal-clad cable.
- G. Wiring connectors.
- H. Electrical tape.
- I. Heat shrink tubing.
- J. Wire pulling lubricant.
- K. Cable ties.
- L. Firestop sleeves.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 05 - Selective Demolition for Electrical: Disconnection, removal, and/or extension of existing electrical conductors and cables.
- C. Section 26 05 13 - Medium-Voltage Cables: Cables and terminations for systems 601 V through 35,000 V.
- D. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 26 21 00 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conductors.
- G. Section 26 31 00 - Photovoltaic Collectors: Additional wiring requirements for photovoltaic systems.
- H. Section 28 46 00 - Fire Detection and Alarm: Fire alarm system conductors and cables.
- I. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.

1.03 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- C. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation.
- D. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.
- E. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

- G. FM 3971 - Fire Protective Coatings and Wraps for Grouped Cables.
- H. FS A-A-59544 - Cable and Wire, Electrical (Power, Fixed Installation).
- I. IEEE 1210 - IEEE Standard Tests for Determining Compatibility of Cable-Pulling Lubricants with Wire and Cable.
- J. IEEE 383 - IEEE Standard for Qualifying Electric Cables and Splices for Nuclear Facilities.
- K. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- L. NECA 120 - Standard for Installing Armored Cable (AC) and Type Metal-Clad (MC) Cable.
- M. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
- N. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- O. NFPA 70 - National Electrical Code.
- P. UL 4 - Armored Cable.
- Q. UL 44 - Thermoset-Insulated Wires and Cables.
- R. UL 83 - Thermoplastic-Insulated Wires and Cables.
- S. UL 267 - Outline of Investigation for Wire-Pulling Compounds.
- T. UL 486A-486B - Wire Connectors.
- U. UL 486C - Splicing Wire Connectors.
- V. UL 486D - Sealed Wire Connector Systems.
- W. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
- X. UL 854 - Service-Entrance Cables.
- Y. UL 1277 - Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
- Z. UL 1569 - Metal-Clad Cables.
- AA. UL 4703 - Standard for Photovoltaic Wire.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 3. Notify Contracting Officer or Contracting Officer's Representative of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Contracting Officer or Contracting Officer's Representative and obtain direction before proceeding with work.

PART 2 PRODUCTS**2.01 CONDUCTOR AND CABLE APPLICATIONS**

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Service entrance cable is permitted only as follows:
 - 1. Where not otherwise restricted, may be used:
 - a. For underground service entrance, installed in raceway.
- E. Armored cable is permitted only as follows:
 - 1. Where not otherwise restricted, may be used:
 - a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
 - 1) Maximum Length: 6 feet.
 - b. Where concealed above accessible ceilings and under raised floors for branch circuits up to 20 A.
- F. Metal-clad cable is permitted only as follows:
 - 1. Where not otherwise restricted, may be used:
 - a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
 - 1) Maximum Length: 6 feet.
 - b. Where concealed above accessible ceilings for branch circuits up to 20 A.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.
- H. Conductor Material:
 - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
- I. Minimum Conductor Size:
 - 1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.

- 3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
- 2. Control Circuits: 14 AWG.
- J. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- K. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
 - 3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - c. Equipment Ground, All Systems: Green.

2.03 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
 - 1. Copper Building Wire:
 - a. Cerro Wire LLC: www.cerrowire.com/#sle.
 - b. Encore Wire Corporation: www.encorewire.com/#sle.
 - c. General Cable Technologies Corporation: www.generalcable.com/#sle.
 - d. Service Wire Co: www.servicewire.com/#sle.
 - e. Southwire Company: www.southwire.com/#sle.
 - f. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: Single conductor insulated wire.
- C. Conductor Stranding:
 - 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
 - a. Size 4 AWG and Larger: Type XHHW-2.
 - b. Installed Underground: Type XHHW-2.

2.04 SERVICE ENTRANCE CABLE

- A. Manufacturers:
 - 1. Copper Service Entrance Cable:
 - a. Cerro Wire LLC: www.cerrowire.com/#sle.
 - b. Encore Wire Corporation: www.encorewire.com/#sle.
 - c. Service Wire Co: www.servicewire.com/#sle.
 - d. Southwire Company: www.southwire.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.

- B. Service Entrance Cable for Underground Use: NFPA 70, Type USE single-conductor cable listed and labeled as complying with UL 854, Type USE-2, and with UL 44 Type RHH/RHW-2.
- C. Conductor Stranding: Stranded.
- D. Insulation Voltage Rating: 600 V.

2.05 ARMORED CABLE

- A. Manufacturers:
 - 1. AFC Cable Systems Inc: www.afcweb.com/#sle.
 - 2. Encore Wire Corporation: www.encorewire.com/#sle.
 - 3. Southwire Company: www.southwire.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type AC cable listed and labeled as complying with UL 4, and listed for use in classified firestop systems to be used.
- C. Conductor Stranding:
 - 1. Size 10 AWG and Smaller: Solid.
 - 2. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation: Type THHN.
- F.
- G. Grounding: Combination of interlocking armor and integral bare bonding wire.
- H. Armor: Steel, interlocked tape.

2.06 METAL-CLAD CABLE

- A. Manufacturers:
 - 1. AFC Cable Systems Inc: www.afcweb.com/#sle.
 - 2. Encore Wire Corporation: www.encorewire.com/#sle.
 - 3. Service Wire Co: www.servicewire.com/#sle.
 - 4. Southwire Company: www.southwire.com/#sle.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
- C. Conductor Stranding:
 - 1. Size 10 AWG and Smaller: Solid.
 - 2. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation: Type THHN/THWN or THHN/THWN-2.
- F. Grounding: Full-size integral equipment grounding conductor.
- G. Armor: Steel, interlocked tape.

2.07 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.
- C. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- D. Wiring Connectors for Terminations:

1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
2. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
3. Conductors for Control Circuits: Use crimped terminals for all connections.
- E. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
 1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. NSI Industries LLC: www.nsiindustries.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- F. Mechanical Connectors: Provide bolted type or set-screw type.
 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. nVent ILSCO: www.ilsco.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- G. Compression Connectors: Provide circumferential type or hex type crimp configuration.
 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. nVent ILSCO: www.ilsco.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- H. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. IlSCO: www.ilsco.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

2.08 ACCESSORIES

- A. Electrical Tape:
 1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Plymouth Rubber Europa: www.plymouthrubber.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
 3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
 4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
 5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
 6. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.

- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
 - 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Thomas & Betts Corporation: www.tnb.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Wire Pulling Lubricant:
 - 1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. American Polywater Corporation: www.polywater.com/#sle.
 - c. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Listed and labeled as complying with UL 267.
 - 3. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
 - 4. Suitable for use at installation temperature.
 - 5. Products:
 - a. American Polywater Corporation; Polywater J Cable Pulling Lubricant: www.polywater.com/#sle.
 - b. American Polywater Corporation; Polywater LZ Cable Pulling Lubricant: www.polywater.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Cable Ties: Material and tensile strength rating suitable for application.
 - 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
 - 1. Products:
 - a. Substitutions: See Section 01 60 00 - Product Requirements.
- F. Fire-Protective Coating for Electrical Conductors and Cables: Field-applied, intumescent or ablative coating designed to prevent ignition and propagation of fire along thermoplastic-insulated conductors and cables.
 - 1. Pass flammability tests of one of the following:
 - a. ASTM E84, Class A; maximum flame spread index of 25.
 - b. FM 3971.
 - c. IEEE 383.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

- A. Circuiting Requirements:

1. Unless dimensioned, circuit routing indicated is diagrammatic.
 2. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 3. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
 4. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
 5. Provide oversized neutral/grounded conductors where indicated and as specified below.
 - a. Provide 200 percent rated neutral for feeders fed from K-rated transformers.
- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Install armored cable (Type AC) in accordance with NECA 120.
- E. Install metal-clad cable (Type MC) in accordance with NECA 120.
- F. Installation in Raceway:
1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 2. Pull all conductors and cables together into raceway at same time.
 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
- I. Terminate cables using suitable fittings.
1. Armored Cable (Type AC):
 - a. Use listed fittings and anti-short, insulating bushings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
 2. Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
- J. Install conductors with a minimum of 12 inches of slack at each outlet.
- K. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- L. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- M. Make wiring connections using specified wiring connectors.
1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 3. Do not remove conductor strands to facilitate insertion into connector.

4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- N. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
- O. Insulate ends of spare conductors using vinyl insulating electrical tape.
- P. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- Q. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- R. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
 1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.
- F. Ground plate electrodes.
- G. Ground access wells.

1.02 RELATED REQUIREMENTS

- A. Section 13 46 13 - Lightning Protection for Structures.
- B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 56 00 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.03 REFERENCE STANDARDS

- A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- E. NFPA 70 - National Electrical Code.
- F. NFPA 780 - Standard for the Installation of Lightning Protection Systems.
- G. UL 467 - Grounding and Bonding Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify exact locations of underground metal water service pipe entrances to building.
 - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
 - 3. Notify Contracting Officer or Contracting Officer's Representative of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- D. Grounding System Resistance:
 - 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Contracting Officer or Contracting Officer's Representative. Precipitation within the previous 48 hours does not constitute normally dry conditions.
 - 2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
- E. Grounding Electrode System:
 - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 - 2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
 - 3. Metal In-Ground Support Structure:
 - a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
 - 4. Concrete-Encased Electrode:
 - a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
 - 5. Ground Ring:
 - a. Provide a ground ring encircling the building or structure consisting of bare copper conductor not less than 2 AWG in direct contact with earth, installed at a depth of not less than 30 inches.
 - b. Provide connection from ground ring conductor to:
 - 1) Perimeter columns of metal building frame.
 - 2) Ground rod electrodes located as indicated.
 - 6. Ground Rod Electrode(s):
 - a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.

- b. Space electrodes not less than 10 feet from each other and any other ground electrode.
 - c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
- 7. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
- 8. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
 - a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
 - b. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
- F. Service-Supplied System Grounding:
 - 1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
 - 2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
- G. Bonding and Equipment Grounding:
 - 1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 - 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
 - 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
 - 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
 - 5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
 - 6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
 - 7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
 - 8. Provide bonding for metal building frame.
- H. Communications Systems Grounding and Bonding:
 - 1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
 - 2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
 - a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
 - b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
 - c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.

- d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
- I. Lightning Protection Systems:
 - 1. See Section 13 46 13 for additional requirements.
 - 2. Do not use grounding electrode dedicated for lightning protection system for component of building grounding electrode system provided under this section.
 - 3. Provide bonding of building grounding electrode system provided under this section and lightning protection grounding electrode system in accordance with NFPA 70 and NFPA 780.

2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 - 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
 - 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
 - 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 - 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 - 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
 - 4. Manufacturers - Mechanical and Compression Connectors:
 - a. allG Fabrication: www.allgfab.com/#sle.
 - b. Burndy LLC: www.burndy.com/#sle.
 - c. Harger Lightning & Grounding: www.harger.com/#sle.
 - d. nVent ERICO: www.nvent.com/#sle.
 - e. Thomas & Betts Corporation: www.tnb.com/#sle.
 - f. Substitutions: See Section 01 60 00 - Product Requirements.
 - 5. Manufacturers - Exothermic Welded Connections:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. nVent ERICO; Cadweld: www.nvent.com/#sle.
 - c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Ground Bars:
 - 1. Description: Copper rectangular ground bars with mounting brackets and insulators.
 - 2. Size: As indicated.
 - 3. Holes for Connections: As indicated or as required for connections to be made.
 - 4. Manufacturers:
 - a. allG Fabrication: www.allgfab.com/#sle.
 - b. Harger Lightning & Grounding: www.harger.com/#sle.
 - c. nVent ERICO: www.nvent.com/#sle.
 - d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.

- E. Ground Rod Electrodes:
 - 1. Comply with NEMA GR 1.
 - 2. Material: Copper-bonded (copper-clad) steel.
 - 3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
 - 4. Manufacturers:
 - a. allG Fabrication: www.allgfab.com/#sle.
 - b. Galvan Industries, Inc: www.galvanelectrical.com/#sle.
 - c. Harger Lightning & Grounding: www.harger.com/#sle.
 - d. nVent ERICO: www.nvent.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
- F. Ground Plate Electrodes:
 - 1. Material: Copper.
 - 2. Size: 24 by 24 by 1/4 inches, unless otherwise indicated.
 - 3. Manufacturers:
 - a. allG Fabrication; _____: www.allgfab.com/#sle.
 - b. Harger Lightning & Grounding; _____: www.harger.com/#sle.
 - c. nVent ERICO; _____: www.nvent.com/#sle.
 - d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC; _____: www.thermoweld.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
- G. Ground Access Wells:
 - 1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
 - 2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
 - a. Round Wells: Not less than 8 inches in diameter.
 - 3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.
 - 4. Cover: Factory-identified by permanent means with word "GROUND".
 - 5. Manufacturers:
 - a. allG Fabrication: www.allgfab.com/#sle.
 - b. Harger Lightning & Grounding: www.harger.com/#sle.
 - c. nVent ERICO: www.nvent.com/#sle.
 - d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
 - 1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
 - 2. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.
- D. Ground Plate Electrodes: Unless otherwise indicated, install ground plate electrodes at a depth of not less than 30 inches.
- E. Make grounding and bonding connections using specified connectors.

1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- F. Identify grounding and bonding system components in accordance with Section 26 05 53.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.13.
- D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 05 33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- C. Section 26 05 33.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.
- D. Section 26 51 00 - Interior Lighting: Additional support and attachment requirements for interior luminaires.
- E. Section 26 56 00 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.
- F. Section 27 05 29 - Hangers and Supports for Communications Systems.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- D. MFMA-4 - Metal Framing Standards Publication.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- F. NFPA 70 - National Electrical Code.
- G. NFPA 101 - Life Safety Code.
- H. UL 5B - Strut-Type Channel Raceways and Fittings.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
 - 2. Coordinate work to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
 - 4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
 - 5. Notify Contracting Officer or Contracting Officer's Representative of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 03 30 00.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

1.06 QUALITY ASSURANCE

- A. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS**2.01 SUPPORT AND ATTACHMENT COMPONENTS**

- A. General Requirements:
 - 1. Comply with the following. Where requirements differ, comply with most stringent.
 - a. NFPA 70.
 - b. Requirements of authorities having jurisdiction.
 - 2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.
 - 3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
 - 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 - 6. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 - 7. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.
 - 1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 3. Conduit Clamps: Bolted type unless otherwise indicated.
 - 4. Products:
 - a. Gripple, Inc; Universal Bracket: www.gripple.com/#sle.
 - b. Gripple, Inc; Fast Trak: www.gripple.com/#sle.
 - c. Gripple, Inc; Universal Clamp (Threaded): www.gripple.com/#sle.
 - d. Gripple, Inc; Low Profile Bracket Kits: www.gripple.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
 - 1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.

- c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Metal Channel/Strut Framing Systems:
- 1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Atkore International Inc; Unistrut: www.unistrut.us/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
 - 3. Comply with MFMA-4.
 - 4. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 - 5. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
 - 6. Minimum Channel Dimensions: 1-5/8 inch wide by 13/16 inch high.
- E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
- 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2-inch diameter.
 - b. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch diameter.
 - c. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch diameter.
 - d. Trapeze Support for Multiple Conduits: 3/8-inch diameter.
 - e. Outlet Boxes: 1/4-inch diameter.
 - f. Luminaires: 1/4-inch diameter.
- F. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
- 1. Manufacturers:
 - a. Atkore International Inc; Unistrut: www.unistrut.us/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.
 - c. Green Link, Inc: www.greenlinkengineering.com/#sle.
 - d. PHP Systems/Design: www.phpsd.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Description: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring attachment to roof structure and not penetrating roofing assembly, with support fixtures as specified.
 - 3. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - 4. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
 - 5. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
- G. Anchors and Fasteners:
- 1. Manufacturers - Mechanical Anchors:
 - a. Dewalt: anchors.dewalt.com/#sle.
 - b. Hilti, Inc: www.hilti.com/#sle.
 - c. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
 - 3. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 - 4. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 - 5. Hollow Masonry: Use toggle bolts.

6. Hollow Stud Walls: Use toggle bolts.
7. Steel: Use beam clamps, machine bolts, or welded threaded studs.
8. Plastic and lead anchors are not permitted.
9. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Manufacturer: Same as manufacturer of metal channel/strut framing system.
 - b. Comply with MFMA-4.
 - c. Channel Material: Use galvanized steel.
 - d. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
10. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install hangers and supports in accordance with NECA 1.
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- E. Unless specifically indicated or approved by Contracting Officer or Contracting Officer's Representative, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Contracting Officer or Contracting Officer's Representative, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Equipment Support and Attachment:
 1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
 2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- I. Conduit Support and Attachment: See Section 26 05 33.13 for additional requirements.
- J. Box Support and Attachment: See Section 26 05 33.16 for additional requirements.
- K. Interior Luminaire Support and Attachment: See Section 26 51 00 for additional requirements.
- L. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- M. Secure fasteners in accordance with manufacturer's recommended torque settings.
- N. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

**SECTION 26 05 33.13
CONDUIT FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Galvanized steel rigid metal conduit (RMC).
- B. PVC-coated galvanized steel rigid metal conduit (RMC).
- C. Flexible metal conduit (FMC).
- D. Liquidtight flexible metal conduit (LFMC).
- E. Electrical metallic tubing (EMT).
- F. Rigid polyvinyl chloride (PVC) conduit.
- G. Conduit fittings.
- H. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete encasement of conduits.
- B. Section 07 84 00 - Firestopping.
- C. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Metal clad cable (Type MC), armored cable (Type AC), and manufactured wiring systems, including uses permitted.
- D. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- E. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- F. Section 26 05 33.16 - Boxes for Electrical Systems.
- G. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- H. Section 26 21 00 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conduits.
- I. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.

1.03 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC).
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S).
- C. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit -- Aluminum (ERMC-A).
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT).
- F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- G. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit.
- H. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit.
- I. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
- J. NFPA 70 - National Electrical Code.
- K. UL 1 - Flexible Metal Conduit.
- L. UL 6 - Electrical Rigid Metal Conduit-Steel.
- M. UL 360 - Liquid-Tight Flexible Metal Conduit.

- N. UL 514B - Conduit, Tubing, and Cable Fittings.
- O. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
- P. UL 797 - Electrical Metallic Tubing-Steel.
- Q. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
- B. Sequencing:
 - 1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
- B. Underground:
 - 1. Under Slab on Grade: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
 - 2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
 - 3. Exterior, Embedded Within Concrete: Use rigid PVC conduit.
 - 4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
 - 5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
 - 6. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape to provide supplementary corrosion protection or use PVC-coated galvanized steel rigid metal conduit.
 - 7. Where steel conduit emerges from concrete into soil, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on either side of where conduit emerges or use PVC-coated galvanized steel rigid metal conduit.
- C. Embedded Within Concrete:
 - 1. Within Slab on Grade: Not permitted.
- D. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).
- E. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).

- F. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).
- G. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.
- H. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).
- I. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.
 - 1. Locations subject to physical damage include, but are not limited to:
 - a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
- J. Exposed, Exterior: Use galvanized steel rigid metal conduit or PVC-coated galvanized steel rigid metal conduit.
- K. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit.

2.02 CONDUIT REQUIREMENTS

- A. Electrical Service Conduits: Also comply with Section 26 21 00.
- B. Communications Systems Conduits: Also comply with Section 27 10 00.
- C. Fittings for Grounding and Bonding: Also comply with Section 26 05 26.
- D. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- E. Provide products listed, classified, and labeled as suitable for the purpose intended.
- F. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Branch Circuits: 3/4 inch (21 mm) trade size.
 - 2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
 - 3. Flexible Connections to Luminaires: 3/4" inch (21 mm) trade size.
 - 4. Underground, Exterior: 1 inch (27 mm) trade size.
- G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- H. Conduit raceway for Telecommunication (Non-SIPR) cabling must be in factory finished blue conduit and be separate from all other systems. Conduit raceway for HVAC control cabling must be in factory finished green conduit and be separate from all other systems. The conduit raceway system for Fire Alarm System cabling must be in factory finished red conduit and be separate from all other systems. The conduit raceway system for CCTV, Intrusion Detection, Access Control and Public Address System cabling must be in factory finished orange conduit and be separate from all other systems.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 - 2. Nucor Tubular Products: www.nucortubular.com/#sle.
 - 3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
 - 4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
 - 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

2.04 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 1. Thomas & Betts Corporation: www.tnb.com/#sle.
 2. Robroy Industries: www.robroy.com/#sle.
 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.
- D. PVC-Coated Fittings:
 1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
 2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.
 4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.
- E. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

2.05 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
 1. AFC Cable Systems, Inc: www.afcweb.com/#sle.
 2. Electri-Flex Company: www.electriflex.com/#sle.
 3. International Metal Hose: www.metalhose.com/#sle.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- C. Fittings:
 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
 1. AFC Cable Systems, Inc: www.afcweb.com/#sle.
 2. Electri-Flex Company: www.electriflex.com/#sle.
 3. International Metal Hose: www.metalhose.com/#sle.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Fittings:
 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.

2.07 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 - 2. Nucor Tubular Products: www.nucortubular/#sle.
 - 3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
 - 4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
 - 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - b. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.
 - 4. Connectors and Couplings: Use set-screw type.
 - a. Do not use indenter type connectors and couplings.

2.08 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Manufacturers:
 - 1. Cantex Inc: www.cantexinc.com/#sle.
 - 2. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com/#sle.
 - 3. JM Eagle: www.jmeagle.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- C. Fittings:
 - 1. Manufacturer: Same as manufacturer of conduit to be connected.
 - 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.09 ACCESSORIES

- A. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- B. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
- C. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.
- D. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.
- E. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.
 - 1. Products:
 - a. Menzies Metal Products; Electrical Roof Stack and Cap: www.menzies-metal.com/#sle.
 - b. Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle.

- c. Substitutions: See Section 01 60 00 - Product Requirements.
- F. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.
 - 1. Manufacturers:
 - a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- G. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
 - 1. Products:
 - a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: www.holdrite.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- H. Duct Bank Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for concrete encasement in open trench installation; suitable for the conduit/duct arrangement to be installed.
 - 1. Products:
 - a. Advance Products & Systems, LLC; Duct Bank Spacers: www.apsonline.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.
- E. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- F. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 - 2. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 - 3. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
 - 4. Arrange conduit to provide no more than 150 feet between pull points.
 - 5. Route conduits above water and drain piping where possible.
 - 6. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 - 7. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
- G. Conduit Support:
 - 1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
 - 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 4. Use conduit strap to support single surface-mounted conduit.
 5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
 6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
 7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
- H. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 2. Use suitable adapters where required to transition from one type of conduit to another.
 3. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
- I. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Conceal bends for conduit risers emerging above ground.
 5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
 6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 7. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- J. Underground Installation:
1. Provide trenching and backfilling in accordance with Section 31 23 16.13.
 2. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 36 inches.
 3. Provide underground warning tape in accordance with Section 26 05 53 along entire conduit length for service entrance where not concrete-encased.
- K. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
- L. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 30 00 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.
- M. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
- N. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- O. Provide grounding and bonding in accordance with Section 26 05 26.
- P. Identify conduits in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

- A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

3.04 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

**SECTION 26 05 33.16
BOXES FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Boxes and enclosures for integrated power, data, and audio/video.
- D. Floor boxes.
- E. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 08 31 00 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
- C. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- D. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- E. Section 26 05 33.13 - Conduit for Electrical Systems:
 - 1. Conduit bodies and other fittings.
- F. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- G. Section 26 27 26 - Wiring Devices:
 - 1. Wall plates.
 - 2. Additional requirements for locating boxes for wiring devices.
- H. Section 27 10 00 - Structured Cabling: Additional requirements for communications systems outlet boxes.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- F. NFPA 70 - National Electrical Code.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- I. UL 508A - Industrial Control Panels.
- J. UL 514A - Metallic Outlet Boxes.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Contracting Officer or Contracting Officer's Representative of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Maintenance Materials: Furnish the following for Government's use in maintenance of project.
 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 2. Keys for Lockable Enclosures: Two of each different key.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 BOXES

- A. General Requirements:
 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 3. Provide products listed, classified, and labeled as suitable for the purpose intended.
 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
 1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 2. Use cast iron boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 3. Use cast iron boxes where exposed galvanized steel rigid metal conduit is used.
 4. Use suitable concrete type boxes where flush-mounted in concrete.
 5. Use suitable masonry type boxes where flush-mounted in masonry walls.
 6. Use raised covers suitable for the type of wall construction and device configuration where required.
 7. Use shallow boxes where required by the type of wall construction.
 8. Do not use "through-wall" boxes designed for access from both sides of wall.
 9. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.

10. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 11. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 12. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
 13. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
 - b. Communications Systems Outlets: Comply with Section 27 10 00.
 14. Wall Plates: Comply with Section 26 27 26.
 15. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. E-Lids LLC: www.e-lids.com/#sle.
 - c. Hubbell Incorporated; Bell Products: www.hubbell-rtb.com/#sle.
 - d. Hubbell Incorporated; RACO Products: www.hubbell-rtb.com/#sle.
 - e. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - f. Thomas & Betts Corporation: www.tnb.com/#sle.
 - g. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA EN 10250 Environment Type, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1, painted steel.
 - b. Outdoor Locations: Type 3R, painted steel.
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 - b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
 4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
 - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
 - b. Back Panels: Painted steel, removable.
 - c. Terminal Blocks: Provide voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.
 5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
 6. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com/#sle.
 - c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ACCESSORIES

- A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for boxes and facade materials to be installed.
1. Manufacturers:
 - a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Box Locations:
 - 1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 31 00 as required where approved by the Architect.
 - 2. Locate boxes as required for devices installed under other sections or by others.
 - a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 27 26.
 - b. Communications Systems Outlets: Comply with Section 27 10 00.
 - 3. Locate boxes so that wall plates do not span different building finishes.
 - 4. Locate boxes so that wall plates do not cross masonry joints.
 - 5. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
- E. Box Supports:
 - 1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
 - 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
- F. Install boxes plumb and level.
- G. Flush-Mounted Boxes:
 - 1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 - 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 - 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- H. Install boxes as required to preserve insulation integrity.
- I. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- J. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- K. Close unused box openings.
- L. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- M. Provide grounding and bonding in accordance with Section 26 05 26.

3.03 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Underground warning tape.
- F. Warning signs and labels.

1.02 RELATED REQUIREMENTS

- A. Section 09 91 13 - Exterior Painting.
- B. Section 09 91 23 - Interior Painting.
- C. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- D. Section 26 05 73 - Power System Studies: Arc flash hazard warning labels.
- E. Section 26 23 00 - Low-Voltage Switchgear: Factory-installed mimic bus.
- F. Section 26 31 00 - Photovoltaic Collectors: Additional identification requirements for photovoltaic systems.
- G. Section 27 10 00 - Structured Cabling: Identification for communications cabling and devices.

1.03 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code.
- B. UL 969 - Marking and Labeling Systems.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
 - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
 - 2. Do not install identification products until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.07 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS**2.01 IDENTIFICATION REQUIREMENTS**

- A. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Switchboards:

- 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - b. Panelboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - 5) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - c. Transformers:
 - 1) Identify kVA rating.
 - 2) Identify voltage and phase for primary and secondary.
 - d. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify voltage and phase.
 2. Service Equipment:
 - a. Use identification nameplate to identify each service disconnecting means.
 - b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
 3. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.
 4. Use identification nameplate to identify switchboards and panelboards utilizing a high leg delta system in accordance with NFPA 70.
 5. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
 6. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
 7. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.
 - a. Service equipment.
 - b. Industrial control panels.
 - c. Motor control centers.
 - d. Elevator control panels.
 - e. Industrial machinery.
 8. Arc Flash Hazard Warning Labels: Comply with Section 26 05 73.
- B. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
 2. Identification for Communications Conductors and Cables: Comply with Section 27 10 00.
 3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
- C. Identification for Raceways:

1. Use voltage markers, color-coded bands, or factory-painted conduits to identify systems other than normal power system for accessible conduits.
 - a. Maximum Intervals: 20 feet.
 - b. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
 - 1) Field-Painting: Comply with Section 09 91 23 and 09 91 13.
 - 2) Vinyl Color Coding Electrical Tape: Comply with Section 26 05 19.
 - c. Color Code:
 - 1) Fire Alarm System: Red.
- D. Identification for Boxes:
 1. Use warning labels to identify electrical hazards for boxes containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
- E. Identification for Devices:
 1. Identification for Communications Devices: Comply with Section 27 10 00.
 2. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.
 3. Factory Pre-Marked Wallplates: Comply with Section 26 27 26.
 4. Use identification label to identify fire alarm system devices.
 5. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
 1. Manufacturers:
 - a. Brimar Industries, Inc: www.brimar.com/#sle.
 - b. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - c. Seton Identification Products: www.seton.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
 3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
 5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
 6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
 1. Manufacturers:
 - a. Brady Corporation: www.bradyid.com/#sle.
 - b. Brother International Corporation: www.brother-usa.com/#sle.
 - c. Panduit Corp: www.panduit.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Format for Equipment Identification:
 1. Minimum Size: 1 inch by 2.5 inches.
 2. Legend:

- a. System designation where applicable:
 - 1) Fire Alarm System: Identify with text "FIRE ALARM".
 - b. Equipment designation or other approved description.
- 3. Text: All capitalized unless otherwise indicated.
- 4. Minimum Text Height:
 - a. System Designation: 1 inch.
 - b. Equipment Designation: 1/2 inch.
- 5. Color:
 - a. Normal Power System: White text on black background.
 - b. Fire Alarm System: White text on red background.
- D. Format for General Information and Operating Instructions:
 - 1. Minimum Size: 1 inch by 2.5 inches.
 - 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 1/4 inch.
 - 5. Color: Black text on white background unless otherwise indicated.

2.03 VOLTAGE MARKERS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradyid.com/#sle.
 - 2. Seton Identification Products: www.seton.com/#sle.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
- C. Minimum Size:
 - 1. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
- D. Legend:
 - 1. Markers for System Identification:
- E. Color: Black text on orange background unless otherwise indicated.

2.04 UNDERGROUND WARNING TAPE

- A. Manufacturers:
 - 1. Brady Corporation: www.bradyid.com/#sle.
 - 2. Brimar Industries, Inc: www.brimar.com/#sle.
 - 3. Seton Identification Products: www.seton.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
- C. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.
- D. Legend: Type of service, continuously repeated over full length of tape.
- E. Color:

2.05 WARNING SIGNS AND LABELS

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.brimar.com/#sle.
 - 2. Clarion Safety Systems, LLC: www.clarionsafety.com/#sle.
 - 3. Insite Solutions, LLC: www.stop-painting.com/#sle.
 - 4. Seton Identification Products: www.seton.com/#sle.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

- C. Warning Signs:
 - 1. Materials:
 - 2. Minimum Size: 7 by 10 inches unless otherwise indicated.
- D. Warning Labels:
 - 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 - 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 - 1. Surface-Mounted Equipment: Enclosure front.
 - 2. Flush-Mounted Equipment: Inside of equipment door.
 - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 - 4. Elevated Equipment: Legible from the floor or working platform.
 - 5. Branch Devices: Adjacent to device.
 - 6. Interior Components: Legible from the point of access.
 - 7. Conduits: Legible from the floor.
 - 8. Boxes: Outside face of cover.
 - 9. Conductors and Cables: Legible from the point of access.
 - 10. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.
- G. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

**SECTION 26 05 73
POWER SYSTEM STUDIES**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Short-circuit study.
- B. Protective device coordination study.
- C. Arc flash and shock risk assessment.
 - 1. Includes arc flash hazard warning labels.
- D. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 53 - Identification for Electrical Systems: Additional requirements for arc flash hazard warning labels.
- B. Section 26 24 13 - Switchboards.
- C. Section 26 24 16 - Panelboards.
- D. Section 26 28 16.13 - Enclosed Circuit Breakers.
- E. Section 26 28 16.16 - Enclosed Switches.

1.03 REFERENCE STANDARDS

- A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels.
- B. IEEE 141 - IEEE Recommended Practice for Electric Power Distribution for Industrial Plants.
- C. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
- D. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis.
- E. IEEE 551 - IEEE Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems.
- F. IEEE 1584 - IEEE Guide for Performing Arc-Flash Hazard Calculations.
- G. NEMA MG 00001 - Motors and Generators.
- H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- I. NFPA 70 - National Electrical Code.
- J. NFPA 70E - Standard for Electrical Safety in the Workplace.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
 - 2. Notify Contracting Officer or Contracting Officer's Representative of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Submit study reports prior to or concurrent with product submittals.
 - 2. Do not order equipment until matching study reports and product submittals have both been evaluated by Contracting Officer or Contracting Officer's Representative.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Study reports, stamped or sealed and signed by study preparer.

- C. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.
 - 1. Identify modifications made in accordance with studies that:
 - a. Can be made at no additional cost to Government.
 - b. As submitted will involve a change to the contract sum.
- D. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.

1.06 POWER SYSTEM STUDIES

- A. Scope of Studies:
 - 1. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).
 - 2. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.
- B. General Study Requirements:
 - 1. Comply with NFPA 70.
 - 2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.
- C. Data Collection:
 - 1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
 - a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
 - 1) Obtain up-to-date information from Owner.
 - b. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 00001 code letter designation.
 - c. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.
 - d. Protective Devices:
 - 1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
 - 2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).
 - e. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
 - f. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.
- D. Short-Circuit Study:
 - 1. Comply with IEEE 551 and applicable portions of IEEE 141, IEEE 242, and IEEE 399.
 - 2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
 - a. Maximum utility fault currents.
 - b. Maximum motor contribution.
 - c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.
- E. Protective Device Coordination Study:
 1. Comply with applicable portions of IEEE 242 and IEEE 399.
 2. Analyze protective devices and associated settings for suitable margins between time-current curves to provide adequate protection for equipment and conductors while achieving full selective coordination.
- F. Arc Flash and Shock Risk Assessment:
 1. Comply with NFPA 70E.
 2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.
 3. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:
 - a. Maximum and minimum utility fault currents.
 - b. Maximum and minimum motor contribution.
 - c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
- G. Study Reports:
 1. General Requirements:
 - a. Identify date of study and study preparer.
 - b. Identify study methodology and software product(s) used.
 - c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.
 - d. Identify base used for per unit values.
 - e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
 - f. Include conclusions and recommendations.
 2. Short-Circuit Study:
 - a. For each scenario, identify at each bus location:
 - 1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
 - 2) Fault point X/R ratio.
 - 3) Associated equipment short circuit current ratings.
 - b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.
 3. Protective Device Coordination Study:
 - a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
 - b. For each graph include (where applicable):
 - 1) Partial single-line diagram identifying the portion of the system illustrated.
 - 2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.
 - 3) Conductors: Damage curves.
 - 4) Transformers: Inrush points and damage curves.
 - 5) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.
 - 6) Motors: Full load current, starting curves, and damage curves.
 - 7) Capacitors: Full load current and damage curves.
 - c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.

- 1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
- 2) Include ground fault pickup and delay.
- 3) Include fuse ratings.
- 4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.
- d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.
4. Arc Flash and Shock Risk Assessment:
 - a. For the worst case for each scenario, identify at each bus location:
 - 1) Calculated incident energy and associated working distance.
 - 2) Calculated arc flash boundary.
 - 3) Bolted fault current.
 - 4) Arcing fault current.
 - 5) Clearing time.
 - 6) Arc gap distance.
 - b. For purposes of producing arc flash hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.

1.07 QUALITY ASSURANCE

- A. Study Preparer Qualifications: Professional electrical engineer licensed in the Commonwealth of Pennsylvania and with minimum five years experience in preparation of studies of similar type and complexity using specified computer software.
- B. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.
 1. Products:
 - a. EasyPower LLC: www.easypower.com/#sle.
 - b. ETAP/Operation Technology, Inc: www.etap.com/#sle.
 - c. Power Analytics Corporation: www.poweranalytics.com/#sle.
 - d. SKM Systems Analysis, Inc: www.skm.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.

PART 2 PRODUCTS

2.01 ARC FLASH HAZARD WARNING LABELS

- A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.
 1. Materials: Comply with Section 26 05 53.
 2. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
 - a. Include the following information:
 - 1) Arc flash boundary.
 - 2) Available incident energy and corresponding working distance.
 - 3) Nominal system voltage.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install arc flash warning labels in accordance with Section 26 05 53.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.

- C. Adjust equipment and protective devices for compliance with studies and recommended settings.
- D. Notify Contracting Officer or Contracting Officer's Representative of any conflicts with or deviations from studies. Obtain direction before proceeding.

3.03 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

END OF SECTION

**SECTION 26 05 83
WIRING CONNECTIONS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Electrical connections to equipment.

1.02 REFERENCE STANDARDS

- A. NEMA WD 1 - General Color Requirements for Wiring Devices.
- B. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
- C. NFPA 70 - National Electrical Code.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
 - 2. Determine connection locations and requirements.
- B. Sequencing:
 - 1. Install rough-in of electrical connections before installation of equipment is required.
 - 2. Make electrical connections before required start-up of equipment.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Comply with NEMA WD 1.
 - 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
 - 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.

- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Occupancy sensors.
- B. Outdoor photo controls.
- C. Digital load controllers.
- D. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems
- D. Section 26 05 33.16 - Boxes for Electrical Systems.
- E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 26 05 73 - Power System Studies.
- G. Section 26 27 26 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, and fan speed controllers.
 - 1. Includes finish requirements for wall controls specified in this section.
- H. Section 26 51 00 - Interior Lighting.
- I. Section 26 56 00 - Exterior Lighting.
- J. Section 28 46 00 - Fire Detection and Alarm.

1.03 REFERENCE STANDARDS

- A. 47 CFR 15 - Radio Frequency Devices.
- B. ANSI C136.10 - American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- E. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- F. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.
- G. NFPA 70 - National Electrical Code.
- H. UL 773 - Plug-in, Locking Type Photocontrols for Use with Area Lighting.
- I. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control.
- J. UL 924 - Emergency Lighting and Power Equipment.
- K. UL 1472 - Solid-State Dimming Controls.
- L. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.
- M. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules.
- N. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate placement of lighting control devices with millwork, furniture, equipment and other potential conflicts.
 - 2. Coordinate placement of wall switch occupancy sensors with installed door swings.
 - 3. Coordinate placement of occupancy sensors with millwork, furniture, equipment and other potential obstructions to motion detection coverage.
 - 4. Coordinate lighting control device product selections with luminaire characteristics; see Section 26 51 00 and lighting fixture schedule.
 - 5. Notify Contracting Officer or Contracting Officer's Representative of conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
- B. Sequencing:
 - 1. Do not install lighting control devices until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings:
 - 1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.
 - 2. Digital Load Controllers: Provide dimensioned plan views indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing factory and field connections. Include manufacturer product characteristics and application instructions for wired and wireless applications, including start-up and commissioning.
- C. Field quality control reports.

1.06 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- C. Product Evaluation and Listing Organization Qualifications: Organization engaged in evaluation of products and services, including those recognized by OSHA as Nationally Recognized Testing Laboratories (NRTL), and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Store products in clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for occupancy sensors.

PART 2 PRODUCTS**2.01 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS**

- A. Provide products listed, classified, and labeled as suitable for purpose intended.
- B. Unless specifically indicated as excluded, provide components necessary for complete operating system including, but not limited to, conduit, wiring, connectors, hardware, and accessories.

2.02 OCCUPANCY SENSORS

- A. Manufacturers:
 - 1. Acuity Brands, Inc: www.acuitybrands.com/#sle.
 - 2. Hubbell Incorporated: www.hubbell.com/#sle.
 - 3. Intermatic, Inc: www.intermatic.com/#sle.
 - 4. Legrand North America, Inc: www.legrand.us/#sle.
 - 5. Lutron Electronics Company, Inc: www.lutron.com/#sle.
 - 6. RAB Lighting, Inc: www.rablighting.com/#sle.
 - 7. Substitutions: See Section 01 60 00 - Product Requirements.
- B. General Requirements:
 - 1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
 - 2. Sensor Technology:
 - a. Passive Infrared (PIR) Occupancy Sensors: Designed to detect occupancy by sensing movement of thermal energy between zones.
 - 3. Provide LED to visually indicate motion detection.
 - 4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during adjustable turn-off delay time interval.
 - 5. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
 - 6. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.
 - 7. Compatibility (Non-Dimming Sensors): Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.
 - 8. Load Rating for Line Voltage Occupancy Sensors: As required to control load indicated on drawings.
- C. Wall Switch Occupancy Sensors:
 - 1. General Requirements:
 - a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
 - b. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during delayed-off time interval.
 - 2. Passive Infrared (PIR) Wall Switch Occupancy Sensors: Capable of detecting motion within area of 900 square feet.
- D. Wall Dimmer Occupancy Sensors:
 - 1. General Requirements:
 - a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with field of view of 180 degrees, integrated dimming control capability, and no leakage current to load in off mode.
 - b. Dimmer: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, and listed as complying with UL 1472; type and rating suitable for load controlled.
 - c. Finish: Match finishes specified for wiring devices in Section 26 27 26, unless otherwise indicated.

2. Passive Infrared (PIR) Wall Dimmer Occupancy Sensors: Capable of detecting motion within area of 900 square feet.
- E. Ceiling Mounted Occupancy Sensors:
 1. General Requirements:
 - a. Description: Low profile occupancy sensors designed for ceiling installation.
 - b. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
 2. Passive Infrared (PIR) Ceiling Mounted Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within area of 450 square feet at mounting height of 9 feet, with field of view of 360 degrees.
- F. Directional Occupancy Sensors:
 1. General Requirements:
 - a. Description: Occupancy sensors designed for wall or ceiling mounting, with integral swivel for field adjustment of motion detection coverage.
 - b. Provide field selectable setting for disabling LED motion detector visual indicator.
 2. Passive Infrared (PIR) Directional Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within distance of 85 to 90 feet and 55 to 60 feet at mounting height of 10 feet.
- G. Accessories:
 1. Provide heavy duty coated steel wire protective guards compatible with specified occupancy sensors where indicated.

2.03 DIGITAL LOAD CONTROLLERS

- A. Manufacturers:
 1. Hubbell Control Solutions: www.hubbell.com/hubbellcontrolsolutions/en/#sle.
 2. Intermatic, Inc: www.intermatic.com/#sle.
 3. Lutron Electronics Company, Inc: www.lutron.com/#sle.
 4. Sensor Switch Inc: www.sensorswitch.com/#sle.
 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. System Description:
 1. Stand-alone system, including interconnected modules and accessories, for lighting and plug load low-voltage control as indicated on drawings, schedules, written sequences of operation, and reviewed shop drawings.
 2. Product standard system configurations preconfigured out of box, plug-and-play, automatically self-addressing devices for communications, and without need to field configure or program features, or requiring device setting adjustments. LEDs on unit indicate operation and troubleshooting without software intervention.
 3. Provide quantity and configuration of power and slave packs, communication modules, and load expansion modules, including associated wiring, wired and wireless components, and accessories to control loads indicated.
- C. General Requirements:
 1. Listed for powering and controlling line-voltage loads, power packs, contactors, relays, and other lighting control devices.
 2. Input Supply Voltage: Dual rated for 120/277 VAC.
 3. Cabling Terminations:
 - a. Include two RJ 45 wiring connections.
 4. Compatibility:
 - a. Compatible with luminaires specified with integral sensors; include auxiliary contact closure accessory components for controls indicated.
 5. Provide UL 2043 plenum rated control unit with self-contained relay(s) and low-voltage class 2 transformer, compatible with specified wired and wireless sensors, components, and ballasts/drivers.
 - a. Comply with NFPA 70 for use in plenum spaces.

- b. Provide UL 2043 plenum rating for associated system control components for control indicated.
- 6. Surface Mounting: Standard junction box attachments.
- 7. Provide one auxiliary contact closure output where indicated.
- 8. Minimum Load Rating: As required to control load indicated on drawings.
- 9. Control Inputs:
 - a. Digital: Two.
 - b. Analog: One.
- 10. Output Control Capability:
 - a. Single Zone Switching Modules: One programmable channel.
 - b. Multi-Zone Switching Modules: Up to three separately programmable channels.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.
- F. Verify that service voltage and ratings of lighting control devices are appropriate for service voltage and load requirements at location to be installed.
- G. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes as required for installation of lighting control devices; see Section 26 05 33.16.
 - 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switch Occupancy Sensors: 48 inches above finished floor.
- C. Maintain separation of remote-control, signaling, and power-limited circuits.
 - 1. See manufacturer instructions and Section 26 05 19 for control wiring conductors, wiring methods, and identification requirements.
- D. Install lighting control devices in accordance with manufacturer's instructions.
- E. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- F. Install lighting control devices plumb and level, and held securely in place.
- G. Where required and not furnished with lighting control device, provide wall plate; see Section 26 27 26.
- H. Provide required supports; see Section 26 05 29.
- I. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on

wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect each lighting control device for damage and defects.
- C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.
- D. Correct wiring deficiencies and replace damaged or defective conductors, cables, and lighting control devices.

3.05 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Contracting Officer or Contracting Officer's Representative.
- C. Adjust position of directional occupancy sensors and outdoor motion sensors to achieve optimal coverage as required.
- D. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.

3.06 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.07 COMMISSIONING

- A. See Section 01 91 13 - General Commissioning Requirements for commissioning requirements.

3.08 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

END OF SECTION

SECTION 26 12 00
MEDIUM-VOLTAGE TRANSFORMERS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Liquid-filled pad-mounted distribution transformers.
- B. Dry-type pad-mounted distribution transformers.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Pads for transformer support.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

1.03 REFERENCE STANDARDS

- A. IEEE 386 - IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV.
- B. IEEE C37.47 - IEEE Standard Specifications for High-Voltage (>1000 V) Distribution Class Current-Limiting Type Fuses and Fuse Disconnecting Switches.
- C. IEEE C57.12.00 - IEEE Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
- D. IEEE C57.12.01 - IEEE Standard for General Requirements for Dry-Type Distribution and Power Transformers.
- E. IEEE C57.12.28 - IEEE Standard for Pad-Mounted Equipment--Enclosure Integrity.
- F. IEEE C57.12.90 - IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers.
- G. IEEE C57.12.91 - IEEE Standard Test Code for Dry-Type Distribution and Power Transformers.
- H. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers.
- I. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers.
- J. IEEE C57.111 - IEEE Standard Guide for Acceptance of Silicone Insulating Fluid and Its Maintenance in Transformers.
- K. IEEE C57.121 - IEEE Guide for Acceptance and Maintenance of Less-Flammable Hydrocarbon Fluid in Transformers.
- L. NEMA TP 80049 - Safety Labels for Pad-Mounted Switchgear and Transformers Sited in Public Areas.
- M. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- N. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
- C. Testing Agency Qualifications: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years documented experience.

- D. Products: Listed, classified, and labeled as suitable for the purpose intended.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ABB: www.electrification.us.abb.com/#sle.
- B. Eaton Corporation: www.eaton.com/#sle.
- C. Schneider Electric: www.se.com/#sle.
- D. Siemens Industry, Inc: www.new.siemens.com/#sle.
- E. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 LIQUID-FILLED TRANSFORMERS

- A. Liquid-Filled Transformers: IEEE C57.12.00, three phase, pad-mounted, self-cooled transformer unit.
- B. Cooling and Temperature Rise: IEEE C57.12.00; Class OA. 55 degrees C, self-cooled.
- C. Insulating Liquid: Oil.

2.03 DRY-TYPE TRANSFORMERS

- A. Dry-Type Transformers: IEEE C57.12.01; single phase, pad-mounted, self-cooled transformer unit with solid-cast windings.
- B. Cooling and Temperature Rise: IEEE C57.12.01; Class AA. 220 degree C insulation class with 150 degree C rise over 40 degree C ambient.

2.04 SERVICE CONDITIONS

- A. Meet requirements for usual service conditions described in IEEE C57.12.01 and for the specified unusual service conditions.

2.05 ACCESSORIES

- A. Accessories: IEEE C57.12.00 standard accessories and IEEE C57.12.01 standard accessories.
- B. Primary Terminations: Bushing wells to IEEE 386; provide three for radial feed. Include bushings for insulated loadbreak connectors.
- C. Primary Overcurrent Protection: Internally-mounted, liquid-immersed, expulsion fuses.
- D. Secondary Terminations: Spade lugs.

2.06 FABRICATION

- A. Comply with the requirements of IEEE C57.12.28.

2.07 FACTORY FINISHING

- A. Clean surfaces before applying paint.
- B. Apply corrosion-resisting primer to all surfaces.
- C. Apply finish coat of baked enamel paint to 2 mils thick.

2.08 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Provide factory tests to IEEE C57.12.90 and IEEE C57.12.00. Include the routine tests as defined in the standards and the following other tests:

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that support pads provided under Section 03 30 00 are ready to receive products.
- B. Verify that field measurements are as indicated on shop drawings.

3.02 INSTALLATION

- A. Provide required support and attachment in accordance with Section 26 05 29.
- B. Install plumb and level.
- C. Install safety labels to NEMA TP 80049.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.2. Tests listed as optional are not required.

3.04 ADJUSTING

- A. Adjust primary taps so that secondary voltage is above and within 2 percent of rated voltage.

END OF SECTION

SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. General purpose transformers.
- B. K-factor transformers rated for nonlinear loads.
- C. Shielded transformers.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 33.13 - Conduit for Electrical Systems: Flexible conduit connections.
- E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 26 24 16 - Panelboards.

1.03 REFERENCE STANDARDS

- A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers.
- B. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers.
- C. IEEE C57.96 - IEEE Standard Guide for Loading Dry-Type Distribution and Power Transformers.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers.
- F. NEMA ST 20 - Dry Type Transformers for General Applications.
- G. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- I. NFPA 70 - National Electrical Code.
- J. UL 506 - Standard for Specialty Transformers.
- K. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate the work with placement of supports, anchors, etc. required for mounting.
 - 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 5. Notify Contracting Officer or Contracting Officer's Representative of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

- B. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.
 - 1. K-factor Rated Transformers: Include K-factor ratings.
 - 2. Shielded Transformers: Include shielding method and noise attenuation performance.
- C. Source Quality Control Test Reports: Include reports for tests designated in NEMA ST 20 as design and routine tests.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Ambient Temperature: Do not exceed the following maximum temperatures during and after installation of transformers.
 - 1. Greater than 10 kVA: 104 degrees F maximum.
 - 2. Less than 10 kVA: 77 degrees F maximum.

1.09 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ABB: www.electrification.us.abb.com/#sle.
- B. Eaton Corporation: www.eaton.com/#sle.
- C. Schneider Electric: www.se.com/#sle.
- D. Siemens Industry, Inc: www.new.siemens.com/#sle.
- E. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 TRANSFORMERS - GENERAL REQUIREMENTS

- A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.
- B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
 - 1. Altitude: Less than 3,300 feet.
 - 2. Ambient Temperature:
 - a. Greater than 10 kVA: Not exceeding 104 degrees F.
 - b. Less than 10 kVA: Not exceeding 77 degrees F.
- C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point,

even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.

- D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.
- E. Basic Impulse Level: 10 kV.
- F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- G. Isolate core and coil from enclosure using vibration-absorbing mounts.
- H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.03 GENERAL PURPOSE TRANSFORMERS

- A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.
- B. Primary Voltage: 480 volts delta, 3 phase.
- C. Secondary Voltage: 208Y/120 volts, 3 phase.
- D. Insulation System and Allowable Average Winding Temperature Rise:
 - 1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.
 - 2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.
- E. Coil Conductors: Continuous aluminum windings with terminations brazed or welded.
- F. Winding Taps:
 - 1. Less than 3 kVA: None.
 - 2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
 - 3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
 - 4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.
- G. Energy Efficiency: Comply with 10 CFR 431, Subpart K.
- H. Sound Levels: Standard sound levels complying with NEMA ST 20
- I. Mounting Provisions:
 - 1. Less than 15 kVA: Suitable for wall mounting.
 - 2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
 - 3. Larger than 75 kVA: Suitable for floor mounting.
- J. Transformer Enclosure: Comply with NEMA ST 20.
 - 1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor clean, dry locations: Type 2.
 - 2. Construction: Steel.
 - a. Less than 15 kVA: Totally enclosed, non-ventilated.
 - b. 15 kVA and Larger: Ventilated.
 - 3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
 - 4. Provide lifting eyes or brackets.
- K. Accessories:
 - 1. Mounting Brackets: Provide manufacturer's standard brackets.
 - 2. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

2.04 K-FACTOR TRANSFORMERS RATED FOR NONLINEAR LOADS

- A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 1561, and designed to supply nonlinear loads to the degree designated by the UL defined K-factor; ratings as indicated on the drawings.
- B. Primary Voltage: 480 volts delta, 3 phase.
- C. Secondary Voltage: 208Y/120 volts, 3 phase.
- D. K-factor Rating: K-4, or higher.
- E. Insulation System and Allowable Average Winding Temperature Rise: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.
- F. Coil Conductors: Continuous aluminum windings with terminations brazed or welded. Individually insulate secondary conductors and arrange to minimize hysteresis and eddy current losses at harmonic frequencies. Size secondary neutral conductor at twice the secondary phase conductor ampacity.
- G. Winding Taps: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
- H. Neutral Bus: Sized to accommodate twice the rated secondary current.
- I. Energy Efficiency: Comply with 10 CFR 431, Subpart K.
- J. Sound Levels: Standard sound levels complying with NEMA ST 20
- K. Mounting Provisions:
 - 1. Up to 75 kVA: Suitable for wall, floor, or trapeze mounting.
 - 2. Larger than 75 kVA: Suitable for floor mounting.
- L. Transformer Enclosure: Comply with NEMA ST 20.
 - 1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor clean, dry locations: Type 2.
 - 2. Construction: Steel, ventilated.
 - 3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
 - 4. Provide lifting eyes or brackets.
- M. Accessories:
 - 1. Mounting Brackets: Provide manufacturer's standard brackets.
 - 2. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

2.05 SOURCE QUALITY CONTROL

- A. Factory test transformers according to NEMA ST 20.
- B. Sound Level Tests: Perform factory test designated in NEMA ST 20 as "design" test on each production unit.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.
- C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.

- C. Install transformers in accordance with NECA 409 and IEEE C57.94.
- D. Use flexible conduit, under the provisions of Section 26 05 33.13, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.
- F. Install transformers plumb and level.
- G. Transformer Support:
 - 1. Provide required support and attachment in accordance with Section 26 05 29, where not furnished by transformer manufacturer.
 - 2. Use integral transformer flanges, accessory brackets furnished by manufacturer, or field-fabricated supports to support wall-mounted transformers.
 - 3. Unless otherwise indicated, mount floor-mounted transformers on properly sized 3 inch high concrete pad constructed in accordance with Section 03 30 00.
 - 4. Use trapeze hangers assembled from threaded rods and metal channel (strut) to support suspended transformers. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- H. Provide grounding and bonding in accordance with Section 26 05 26.
- I. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.
- J. Where not factory-installed, install lugs sized as required for termination of conductors as indicated.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required.

3.04 ADJUSTING

- A. Measure primary and secondary voltages and make appropriate tap adjustments.
- B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- A. Clean dirt and debris from transformer components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

**SECTION 26 24 16
PANELBOARDS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Power distribution panelboards.
- B. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 05 73 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.
- E. Section 26 22 00 - Low-Voltage Transformers: Small power centers with integral primary breaker, transformer, and panelboard.
- F. Section 26 27 13 - Electricity Metering: For interface with equipment specified in this section.
- G. Section 26 43 00 - Surge Protective Devices.

1.03 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards.
- D. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- F. NEMA PB 1 - Panelboards.
- G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 1000V or Less.
- H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- I. NFPA 70 - National Electrical Code.
- J. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- K. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- L. UL 67 - Panelboards.
- M. UL 98 - Enclosed and Dead-Front Switches.
- N. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
- O. UL 869A - Reference Standard for Service Equipment.
- P. UL 943 - Ground-Fault Circuit-Interrupters.
- Q. UL 1053 - Ground-Fault Sensing and Relaying Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Contracting Officer or Contracting Officer's Representative of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature within the following limits during and after installation of panelboards:
 1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ABB: www.electrification.us.abb.com/#sle.
- B. Eaton Corporation: www.eaton.com/#sle.
- C. Schneider Electric: www.se.com/#sle.
- D. Siemens Industry, Inc: www.new.siemens.com/#sle.
- E. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 1. Altitude: Less than 6,600 feet.
 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.

2. Label equipment utilizing series ratings as required by NFPA 70.
- D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
- I. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.
 1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - b. Provide removable end walls for NEMA Type 1 enclosures.
 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- K. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 00, list and label panelboards as a complete assembly including surge protective device.
- L. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
 1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
- M. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- N. Load centers are not acceptable.

2.03 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 1. Phase and Neutral Bus Material: Copper.
 2. Ground Bus Material: Copper.
- D. Circuit Breakers:

1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
 2. Provide electronic trip circuit breakers where indicated.
- E. Enclosures:
1. Provide surface-mounted enclosures unless otherwise indicated.
 2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 3. Provide clear plastic circuit directory holder mounted on inside of door.

2.04 OVERCURRENT PROTECTIVE DEVICES

- A. Molded Case Circuit Breakers:
1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Copper, suitable for terminating copper conductors only.
 4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - a. Provide the following field-adjustable trip response settings:
 - 1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - 2) Long time delay.
 - 3) Short time pickup and delay.
 - 4) Instantaneous pickup.
 - 5) Ground fault pickup and delay where ground fault protection is indicated.
 6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
 7. Do not use tandem circuit breakers.
 8. Do not use handle ties in lieu of multi-pole circuit breakers.
 9. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.

2.05 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 26 05 29.
- F. Install panelboards plumb.
- G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- I. Provide grounding and bonding in accordance with Section 26 05 26.
- J. Install all field-installed branch devices, components, and accessories.
- K. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.
- L. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 05 73.
- M. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- N. Provide filler plates to cover unused spaces in panelboards.
- O. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
 - 1. Fire detection and alarm circuits.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers. Tests listed as optional are not required.
- D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
- E. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.05 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 27 13 ELECTRICITY METERING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Equipment for electricity metering:

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 33.16 - Boxes for Electrical Systems: Cabinets and enclosures for metering system components.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 24 13 - Switchboards: For interface with meters specified in this section.
- F. Section 26 24 16 - Panelboards: For interface with meters specified in this section.
- G. Section 26 28 13 - Fuses.

1.03 REFERENCE STANDARDS

- A. ANSI C12.20 - American National Standard for Electricity Meters - 0.1, 0.2, and 0.5 Accuracy Classes.
- B. IEC 62053-21 - Electricity Metering Equipment (A.C.) - Particular Requirements - Part 21: Static Meters for Active Energy (Classes 1 and 2).
- C. IEC 62053-22 - Electricity Metering Equipment (A.C.) - Particular Requirements - Part 22: Static Meters for Active Energy (Classes 0,2 S and 0,5 S).
- D. IEC 62053-23 - Electricity Metering Equipment (A.C.) - Particular Requirements - Part 23: Static Meters for Reactive Energy (Classes 2 and 3).
- E. IEEE 1459 - Standard Definitions for the Measurement of Electrical Power Quantities Under Sinusoidal, Nonsinusoidal, Balanced, or Unbalanced Conditions.
- F. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers.
- G. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- H. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- I. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- J. NFPA 70 - National Electrical Code.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate work to provide equipment suitable for interface with electricity metering systems to be provided.
 - 2. Notify Contracting Officer or Contracting Officer's Representative of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Electricity Meters:
 - 1. Same as manufacturer of electrical distribution equipment used for this project.
 - a. ABB/GE: www.geindustrial.com/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.
 - c. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
 - d. Siemens Industry, Inc: www.usa.siemens.com/#sle.
- B. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 EQUIPMENT FOR OWNER ELECTRICITY METERING

- A. Provide microprocessor-based digital electricity metering systems including all instrument transformers, wiring, and connections necessary for measurements specified.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Provide electricity metering systems and associated components compatible with the equipment and associated circuits to be metered.
- D. Service Conditions: Provide electricity meters suitable for operation under the service conditions at the installed location.
 - 1. Altitude: 330 feet.
- E. Enclosures:
 - 1. Where not furnished by manufacturer, provide required cabinets and enclosures in accordance with Section 26 05 33.16.
 - 2. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - 3. Finish: Manufacturer's standard unless otherwise indicated.
- F. Instrument Transformers:
 - 1. Comply with IEEE C57.13, where applicable.
 - 2. Select suitable ratio, burden, and accuracy as required for connected devices.
 - 3. Current Transformers: Compatible with connected meters; replace meters damaged by connection of incompatible current transformers. Provide shorting terminal blocks for connection of secondaries where applicable.
 - 4. Potential Transformers: Include primary and secondary fuses with disconnecting means.
- G. Interface with Other Work:
 - 1. Interface with building automation system.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of metering systems and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive meters.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.

- C. Provide required support and attachment components in accordance with Section 26 05 29.
- D. Provide grounding and bonding in accordance with Section 26 05 26.
- E. Provide fuses complying with Section 26 28 13 as required.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.
- D. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10. The dielectric withstand tests on primary windings with secondary windings connected to ground listed as optional are not required.
- E. Correct deficiencies and replace damaged or defective metering system components.

3.04 ADJUSTING

- A. Program system parameters according to requirements of Government.

3.05 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. Training: Train personnel on operation, adjustment, and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Manufacturer's authorized representative.
 - 4. Location: At project site.

3.07 PROTECTION

- A. Protect installed system components from subsequent construction operations.

END OF SECTION

**SECTION 26 27 26
WIRING DEVICES****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Wall switches.
- B. Wall dimmers.
- C. Receptacles.
- D. Wall plates.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Manufactured wiring systems for use with access floor boxes with compatible pre-wired connectors.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 33.16 - Boxes for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 05 83 - Wiring Connections: Cords and plugs for equipment.
- F. Section 26 09 23 - Lighting Control Devices: Devices for automatic control of lighting, including occupancy sensors, in-wall time switches, and in-wall interval timers.

1.03 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for.
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- E. NEMA WD 1 - General Color Requirements for Wiring Devices.
- F. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
- G. NFPA 70 - National Electrical Code.
- H. UL 20 - General-Use Snap Switches.
- I. UL 498 - Attachment Plugs and Receptacles.
- J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices.
- K. UL 943 - Ground-Fault Circuit-Interrupters.
- L. UL 1310 - Class 2 Power Units.
- M. UL 1449 - Standard for Surge Protective Devices.
- N. UL 1472 - Solid-State Dimming Controls.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
 - 3. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
 - 4. Notify Contracting Officer or Contracting Officer's Representative of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Products: Listed, classified, and labeled as suitable for the purpose intended.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS**2.01 WIRING DEVICE APPLICATIONS**

- A. Refer to lighting details for additional information.
- B. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- C. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- D. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
- E. Provide GFCI protection for receptacles installed within 6 feet of sinks.
- F. Provide GFCI protection for receptacles serving electric drinking fountains.

2.02 WIRING DEVICE FINISHES

- A. Provide wiring device finishes as described below unless otherwise indicated.
- B. Wiring Devices, Unless Otherwise Indicated: White with white nylon wall plate.
- C. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate.
- D. Wiring Devices Installed in Wet or Damp Locations: White with specified weatherproof cover.

2.03 WALL SWITCHES

- A. Manufacturers:
 - 1. Hubbell Incorporated: www.hubbell.com/#sle.
 - 2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.04 WALL DIMMERS

- A. Manufacturers:
 - 1. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 - 2. Lutron Electronics Company, Inc; Maestro Series: www.lutron.com/#sle.

3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.

2.05 RECEPTACLES

- A. Manufacturers:
1. Hubbell Incorporated: www.hubbell.com/#sle.
 2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 3. Lutron Electronics Company, Inc; Designer Style: www.lutron.com/#sle.
 4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
- C. Convenience Receptacles:
1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
 2. Automatically Controlled Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; controlled receptacle marking on device face per NFPA 70; single or duplex as indicated on the drawings.
 3. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
- D. GFCI Receptacles:
1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
 - a. Provide test and reset buttons of same color as device.
 2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
 3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

2.06 WALL PLATES

- A. Manufacturers:
1. Hubbell Incorporated: www.hubbell-wiring.com/#sle.
 2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.
 3. Lutron Electronics Company, Inc: www.lutron.com/#sle.
 4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.
 5. Substitutions: See Section 01 60 00 - Product Requirements.
 6. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.
- B. Wall Plates: Comply with UL 514D.

1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 2. Size: Standard.
 3. Screws: Metal with slotted heads finished to match wall plate finish.
- C. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.
- D. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- E. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- F. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of wiring devices provided under this section.
 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switches: 48 inches above finished floor.
 - b. Wall Dimmers: 48 inches above finished floor.
 - c. Receptacles: 18 inches above finished floor or 6 inches above counter.
 2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
 4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Contracting Officer or Contracting Officer's Representative to obtain direction prior to proceeding with work.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- I. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- J. Install wall switches with OFF position down.
- K. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- L. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- M. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- N. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- O. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- P. Identify wiring devices in accordance with Section 26 05 53.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- D. Test each receptacle to verify operation and proper polarity.
- E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- F. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.05 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.06 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

**SECTION 26 28 16.13
ENCLOSED CIRCUIT BREAKERS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Enclosed circuit breakers.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 05 73 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

1.03 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- E. NFPA 70 - National Electrical Code.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- H. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
- I. UL 943 - Ground-Fault Circuit-Interrupters.
- J. UL 1053 - Ground-Fault Sensing and Relaying Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. Notify Contracting Officer or Contracting Officer's Representative of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. ABB: www.electrification.us.abb.com/#sle.
- B. Schneider Electric: www.se.com/#sle.
- C. Siemens Industry, Inc: www.new.siemens.com/#sle.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ENCLOSED CIRCUIT BREAKERS

- A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between 23 degrees F and 104 degrees F.
- D. Short Circuit Current Rating:
 - 1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.
- E. Conductor Terminations: Suitable for use with the conductors to be installed.
- F. Provide thermal magnetic circuit breakers unless otherwise indicated.
- G. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.
- H. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
- I. Provide externally operable handle with means for locking in the OFF position.
- J. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

2.03 MOLDED CASE CIRCUIT BREAKERS

- A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
- B. Interrupting Capacity:

1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - a. 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - b. 14,000 rms symmetrical amperes at 480 VAC.
 2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
- C. Conductor Terminations:
1. Provide mechanical lugs unless otherwise indicated.
 2. Lug Material: Copper, suitable for terminating copper conductors only.
- D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
1. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
- E. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
1. Provide the following field-adjustable trip response settings:
 - a. Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - b. Long time delay.
 - c. Short time pickup and delay.
 - d. Instantaneous pickup.
 - e. Ground fault pickup and delay where ground fault protection is indicated.
- F. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Install enclosed circuit breakers plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 05 26.
- H. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 05 73.
- I. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.

- B. Inspect and test in accordance with manufacturer's instructions and NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers used for service entrance and for circuit breakers larger than _____ amperes. Tests listed as optional are not required.
- D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
- E. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- A. Clean dirt and debris from circuit breaker enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

**SECTION 26 28 16.16
ENCLOSED SWITCHES****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Enclosed safety switches.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 05 73 - Power System Studies: Additional criteria for the selection of equipment and associated protective devices specified in this section.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- E. NFPA 70 - National Electrical Code.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- H. UL 98 - Enclosed and Dead-Front Switches.
- I. UL 869A - Reference Standard for Service Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. Notify Contracting Officer or Contracting Officer's Representative of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ABB: www.electrification.us.abb.com/#sle.
- B. Eaton Corporation: www.eaton.com/#sle.
- C. Schneider Electric: www.se.com/#sle.
- D. Siemens Industry, Inc: www.new.siemens.com/#sle.
- E. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
- D. Horsepower Rating: Suitable for connected load.
- E. Voltage Rating: Suitable for circuit voltage.
- F. Short Circuit Current Rating:
 - 1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.
- G. Provide with switch blade contact position that is visible when the cover is open.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
- I. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- J. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
- K. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.

- C. Verify that mounting surfaces are ready to receive enclosed safety switches.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 05 26.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

**SECTION 26 43 00
SURGE PROTECTIVE DEVICES**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Surge protective devices for service entrance locations.
- B. Surge protective devices for distribution locations.
- C. Surge protective devices for branch panelboard locations.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 24 13 - Switchboards.
- C. Section 26 24 16 - Panelboards.

1.03 ABBREVIATIONS AND ACRONYMS

- A. SPD: Surge Protective Device.

1.04 REFERENCE STANDARDS

- A. MIL-STD-220 - Method of Insertion Loss Measurement.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- E. NFPA 70 - National Electrical Code.
- F. UL 1283 - Standard for Electromagnetic Interference Filters.
- G. UL 1449 - Standard for Surge Protective Devices.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Contracting Officer or Contracting Officer's Representative of any conflicts or deviations from Contract Documents to obtain direction prior to ordering equipment.

1.06 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
 - 1. UL 1449.

1.07 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.08 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.09 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Field-Installed, Externally Mounted Surge Protective Devices:
 - 1. ABB: www.electrification.us.abb.com/#sle.
 - 2. Intermatic, Inc: www.intermatic.com/#sle.
 - 3. nVent ERICO: www.nvent.com/#sle.
 - 4. Schneider Electric: www.se.com/#sle.
 - 5. Surge Suppression, LLC (SSI): www.surgesuppression.com/#sle.
- B. Factory-installed, Internally Mounted Surge Protective Devices:
 - 1. Same as manufacturer of equipment containing surge protective device, to provide complete listed assembly including SPD.
 - 2. As shown on drawings.
- C. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

- A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.
- B. Unless otherwise indicated, provide field-installed, externally-mounted or factory-installed, internally-mounted SPDs.
- C. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.
- D. Protected Modes:
 - 1. Wye Systems: L-N, L-G, N-G, L-L.
- E. UL 1449 Voltage Protection Ratings (VPRs):
 - 1. 208Y/120V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
 - 2. 480Y/277V System Voltage: Not more than 1,500 V for L-N, L-G, and N-G modes and 2,000 V for L-L mode.
- F. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.
- G. Enclosure Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - 1. Indoor clean, dry locations: Type 1.
- H. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:
 - 1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.
- I. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.
 - 1. Switchboards: See Section 26 24 13.
 - 2. Panelboards: See Section 26 24 16.

2.03 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

- A. Surge Protective Device:
 - 1. Protection Circuits: Field-replaceable modular or non-modular.
 - 2. Surge Current Rating: Not less than 120 kA per mode/240 kA per phase.
 - 3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
 - 4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
 - 5. Diagnostics:
 - a. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.
 - b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.

2.04 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

- A. Distribution locations include SPDs connected to distribution panelboards.
- B. Surge Protective Device:
 - 1. Protection Circuits: Field-replaceable modular or non-modular.
 - 2. Surge Current Rating: Not less than 80 kA per mode/160 kA per phase.
 - 3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
 - 4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
 - 5. Diagnostics:
 - a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
 - b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.

2.05 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

- A. Surge Protective Device:
 - 1. Protection Circuits: Field-replaceable modular or non-modular.
 - 2. Surge Current Rating: Not less than 60 kA per mode/120 kA per phase.
 - 3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
 - 4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
 - 5. Diagnostics:
 - a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
 - b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that field measurements are as indicated.
- B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.
- C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of drawings and manufacturer's instructions.
- D. Verify system grounding and bonding is in accordance with Section 26 05 26, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- C. Unless indicated otherwise, connect service entrance surge protective device on load side of service disconnect main overcurrent device.
- D. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.
- E. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 05 26 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.

3.04 CLEANING

- A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

**SECTION 26 51 00
INTERIOR LIGHTING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Interior luminaires.
- B. Exit signs.
- C. Ballasts and drivers.
- D. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- B. Section 26 05 33.16 - Boxes for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 09 23 - Lighting Control Devices: Automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.
- E. Section 26 27 26 - Wiring Devices: Manual wall switches and wall dimmers.
- F. Section 26 56 00 - Exterior Lighting.

1.03 REFERENCE STANDARDS

- A. 47 CFR 15 - Radio Frequency Devices.
- B. ANSI C82.4 - American National Standard for Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).
- C. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code).
- D. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits.
- E. IES LM-63 - IESNA Standard File Format for Electronic Transfer of Photometric Data and Related Information.
- F. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.
- G. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules.
- H. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- I. NECA/IESNA 500 - Standard for Installing Indoor Lighting Systems.
- J. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems.
- K. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.
- L. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility.
- M. NFPA 70 - National Electrical Code.
- N. NFPA 101 - Life Safety Code.
- O. UL 924 - Emergency Lighting and Power Equipment.
- P. UL 1598 - Luminaires.
- Q. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
 - 2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
 - 3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
 - 4. Notify Contracting Officer or Contracting Officer's Representative of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
 - 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
 - b. Include IES LM-79 test report upon request.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide three year manufacturer warranty for LED luminaires, including drivers.
- C. Provide five year pro-rata warranty for batteries for emergency lighting units.

PART 2 PRODUCTS**2.01 LUMINAIRE TYPES**

- A. Furnish products as indicated in luminaire schedule included on the drawings.
- B. Substitutions: See Section 01 60 00 - Product Requirements except where individual luminaire types are designated with substitutions not permitted.

2.02 LUMINAIRES

- A. Manufacturers:
 - 1. Acuity Brands, Inc: www.acuitybrands.com/#sle.
 - 2. Alloy LED; www.alloyled.com/#sle.
 - 3. Cooper Lighting, a division of Cooper Industries: www.cooperindustries.com/#sle.
 - 4. Electro-Matic Visual, Inc; www.empvisual.com/#sle.
 - 5. Hubbell Lighting, Inc: www.hubbelllighting.com/#sle.
 - 6. Lutron Electronics Company, Inc; www.lutron.com/#sle.
 - 7. Philips Lighting North America Corporation; www.lightingproducts.philips.com/#sle.
 - 8. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Provide products that comply with requirements of NFPA 70.
- C. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- D. Provide products listed, classified, and labeled as suitable for the purpose intended.
- E. Provide products complying with Federal Energy Management Program (FEMP) requirements.
- F. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- G. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- H. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- I. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
 - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
- J. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.
 - 3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

2.03 EXIT SIGNS

- A. Description: Exit signs complying with NFPA 101 and applicable state and local codes, and listed and labeled as complying with UL 924.
 - 1. Number of Faces: Single- or double-face as indicated or as required for installed location.
 - 2. Directional Arrows: As indicated or as required for installed location.
- B. Powered Exit Signs: Internally illuminated with LEDs unless otherwise indicated.
 - 1. Manufacturers:
 - a. Acuity Brands, Inc: www.acuitybrands.com/#sle.
 - b. Cooper Lighting, a division of Cooper Industries: www.cooperindustries.com/#sle.
 - c. Hubbell Lighting, Inc: www.hubbelllighting.com/#sle.
 - d. Philips Lighting North America Corporation; www.lightingproducts.philips.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Self-Powered Exit Signs:
 - a. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

- b. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
- c. Provide low-voltage disconnect to prevent battery damage from deep discharge.

2.04 BALLASTS AND DRIVERS

- A. Manufacturers:
 - 1. Alloy LED; www.alloyled.com/#sle.
 - 2. General Electric Company/GE Lighting; www.gelighting.com/#sle.
 - 3. Lutron Electronics Company, Inc; www.lutron.com/#sle.
 - 4. OSRAM Sylvania, Inc; www.osram.us/ds/#sle.
 - 5. Philips Lighting North America Corporation; www.usa.lighting.philips.com/#sle.
 - 6. Substitutions: See Section 01 60 00 - Product Requirements.
 - 7. Manufacturer Limitations: Where possible, for each type of luminaire provide ballasts produced by a single manufacturer.
- B. Ballasts/Drivers - General Requirements:
 - 1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
 - 2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.
- C. Dimmable LED Drivers:
 - 1. Dimming Range: Continuous dimming from 100 percent to five percent relative light output unless dimming capability to lower level is indicated, without flicker.
 - 2. Control Compatibility: Fully compatible with the dimming controls to be installed.

2.05 ACCESSORIES

- A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.
- B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install products in accordance with manufacturer's instructions.
- D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).
- E. Provide required support and attachment in accordance with Section 26 05 29.

- F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- G. Suspended Ceiling Mounted Luminaires:
 - 1. Do not use ceiling tiles to bear weight of luminaires.
 - 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
 - 3. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
 - 4. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- H. Recessed Luminaires:
 - 1. Install trims tight to mounting surface with no visible light leakage.
- I. Suspended Luminaires:
 - 1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
 - 2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
- J. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- K. Install accessories furnished with each luminaire.
- L. Bond products and metal accessories to branch circuit equipment grounding conductor.
- M. Exit Signs:
 - 1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Test self-powered exit signs, emergency lighting units, and fluorescent emergency power supply units to verify proper operation upon loss of normal power supply.
- E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Contracting Officer or Contracting Officer's Representative.

3.05 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Contracting Officer or Contracting Officer's Representative. Secure locking fittings in place.
- B. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Contracting Officer or Contracting Officer's Representative or authority having jurisdiction.

3.06 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

3.08 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

**SECTION 26 56 00
EXTERIOR LIGHTING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Exterior luminaires.
- B. Ballasts.
- C. Luminaire accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 33.16 - Boxes for Electrical Systems.
- D. Section 26 09 23 - Lighting Control Devices: Automatic controls for lighting including outdoor motion sensors, time switches, and outdoor photo controls.
- E. Section 26 51 00 - Interior Lighting.

1.03 REFERENCE STANDARDS

- A. 47 CFR 15 - Radio Frequency Devices.
- B. IEEE C2 - National Electrical Safety Code.
- C. IES LM-63 - IESNA Standard File Format for Electronic Transfer of Photometric Data and Related Information.
- D. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.
- E. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules.
- F. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- G. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems.
- H. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.
- I. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility.
- J. NFPA 70 - National Electrical Code.
- K. UL 1598 - Luminaires.
- L. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Notify Contracting Officer or Contracting Officer's Representative of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.
 - 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.

- b. Include IES LM-79 test report upon request.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide three year manufacturer warranty for all LED luminaires, including drivers.

PART 2 PRODUCTS

2.01 LUMINAIRES

- A. Manufacturers:
 - 1. Acuity Brands, Inc: www.acuitybrands.com/#sle.
 - 2. Alloy LED; www.alloyled.com/#sle.
 - 3. Cooper Lighting, a division of Cooper Industries: www.cooperindustries.com/#sle.
 - 4. Electro-Matic Visual, Inc; www.empvisual.com/#sle.
 - 5. Hubbell Lighting, Inc: www.hubbelllighting.com/#sle.
 - 6. Philips Lighting North America Corporation; www.lightingproducts.philips.com/#sle.
 - 7. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Provide products that comply with requirements of NFPA 70.
- C. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- D. Provide products listed, classified, and labeled as suitable for the purpose intended.
- E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.
- G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- H. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.
- I. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.
 - 3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

2.02 BALLASTS AND DRIVERS

- A. Manufacturers:
 - 1. General Electric Company/GE Lighting: www.gelighting.com/#sle.

2. OSRAM Sylvania, Inc: www.osram.us/ds/#sle.
 3. Philips Lighting North America Corporation; www.usa.lighting.philips.com/#sle.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Ballasts/Drivers - General Requirements:
1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
 2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.
- B. Install products in accordance with manufacturer's instructions.
- C. Install luminaires in accordance with NECA/IESNA 501.
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- F. Install accessories furnished with each luminaire.
- G. Bond products and metal accessories to branch circuit equipment grounding conductor.
- H. Install lamps in each luminaire.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Contracting Officer or Contracting Officer's Representative.

3.05 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Contracting Officer or Contracting Officer's Representative. Secure locking fittings in place.

3.06 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

3.07 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 27 05 29
HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other communications work.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 27 05 33.13 - Conduit for Communications Systems: Additional support and attachment requirements for conduits.
- D. Section 27 10 00 - Structured Cabling.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- D. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
- E. ASTM D2256/D2256M - Standard Test Method for Tensile Properties of Yarns by the Single-Strand Method.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- G. BICSI ITSIMM - Information Technology Systems Installation Methods Manual (ITSIMM), 8th Edition.
- H. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition.
- I. MFMA-4 - Metal Framing Standards Publication.
- J. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- K. NFPA 70 - National Electrical Code.
- L. NFPA 101 - Life Safety Code.
- M. TIA-569 - Telecommunications Pathways and Spaces.
- N. UL 5B - Strut-Type Channel Raceways and Fittings.
- O. UL 2024 - Standard for Cable Routing Assemblies and Communications Raceways.
- P. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
 - 2. Coordinate work to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
 - 4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.

5. Notify Contracting Officer or Contracting Officer's Representative of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 03 30 00.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cable supports, channel/strut framing systems, nonpenetrating rooftop supports, and post-installed concrete/masonry anchors.

1.06 QUALITY ASSURANCE

- A. Maintain at project site one copy of each referenced document that prescribes execution requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 1. Comply with the following. Where requirements differ, comply with most stringent.
 - a. TIA-569.
 - b. NFPA 70.
 - c. Requirements of authorities having jurisdiction.
 2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of communications work.
 3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
 5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 6. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit Supports: Straps and clamps suitable for conduit to be supported.
 1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 3. Conduit Clamps: Bolted type unless otherwise indicated.
 4. Products:

- a. Gripple, Inc; Universal Bracket: www.gripple.com/#sle.
 - b. Gripple, Inc; Universal Clamp (Threaded): www.gripple.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Noncontinuous Cable Supports: Suitable for cables to be supported, including but not limited to J-hooks, and flexible harnesses/slings.
 - 1. Manufacturers:
 - a. Eaton Corporation: www.eaton.com/#sle.
 - b. Panduit: www.panduit.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Applications:
 - a. Do not exceed 5 feet between cable supports.
 - b. Maximum Number of Cables per Cable Support:
 - 1) J-Hooks: 50, regardless of capacity.
 - 2) Bridle Rings: _____, regardless of capacity.
 - c. Allowable Cable Types:
 - 1) J-Hooks: Category 6.
 - 2) Bridle Rings with Saddle: Category 6.
 - 3. Cable Supports Installed in Spaces Used for Environmental Air: Plenum rated; listed and labeled as complying with UL 2043, suitable for use in air-handling spaces.
 - 4. J-Hooks: Noncontinuous cabling support with removable top retainer clip.
 - a. Material: Use galvanized steel, factory-painted steel, or stainless steel.
 - b. Provide support surfaces with smooth, beveled edges and radius not less than minimum allowable bend radius of cables supported.
 - c. Provide multitiered J-hooks where required to support multiple cabling systems.
- D. Cable Routing Assemblies:
 - 1. Applications:
 - a. Horizontal Supports: Do not exceed 3 feet and at each end or joint.
 - b. Vertical Supports: Do not exceed 4 feet, unless listed otherwise - maximum one joint between supports.
 - c. Comply with NFPA 70 for cable routing assemblies.
 - d. Provide NFPA 70 required bonding of metal components in accordance with manufacturer written instructions.
 - e. Allowable Cable Types: Category 6.
 - 2. Self-Supporting Inside-Plant Fabric Innerduct:
 - a. Listed as complying with UL 2024; plenum rated.
 - b. Material: Use fire-resistant nylon fabric.
 - c. Multi-cell pathways include preinstalled galvanized stranded steel support wire with color-coded pulling strings.
 - d. Breaking Tensile Strength: Greater than 2,000 lbf, when tested in accordance with ASTM D2256/D2256M.
 - e. Support Wire Load Rating: 920 lbf.
 - f. Pull String Load Rating: 1,250 lbf.
- E. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
 - 1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- F. Metal Channel/Strut Framing Systems:
 - 1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Atkore International Inc; Unistrut: www.unistrut.us/#sle.

- c. Substitutions: See Section 01 60 00 - Product Requirements.
- 2. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
- 3. Comply with MFMA-4.
- 4. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
- 5. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
- 6. Minimum Channel Dimensions: 1-5/8 inch wide by 13/16 inch high.
- G. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch diameter.
 - b. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch diameter.
 - c. Trapeze Support for Multiple Conduits: 3/8-inch diameter.
- H. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
 - 1. Manufacturers:
 - a. PHP Systems/Design: www.phpsd.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Description: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring attachment to roof structure and not penetrating roofing assembly, with support fixtures as specified.
 - 3. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - 4. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
 - 5. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
- I. Rooftop Support Systems for Metal Roofs:
 - 1. Manufacturers:
 - a. Metal Roof Innovations, Ltd. S-5! Attachment Solutions; GRIPPERFIX: www.s-5.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware for field assembly of supports.
 - 3. Standing-Seam Metal Roofs: Use nonpenetrating fasteners that utilize mechanical clamping action for attachment.
 - 4. Exposed-Fastener Metal Roofs: Use piercing fasteners with rubber gaskets.
- J. Anchors and Fasteners:
 - 1. Manufacturers - Mechanical Anchors:
 - a. Dewalt: anchors.dewalt.com/#sle.
 - b. Hilti, Inc: www.hilti.com/#sle.
 - c. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Manufacturers - Powder-Actuated Fastening Systems:
 - a. Dewalt: anchors.dewalt.com/#sle.
 - b. Hilti, Inc: www.hilti.com/#sle.
 - c. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
 - 3. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.

4. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
5. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Sheet Metal: Use sheet metal screws.
8. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Manufacturer: Same as manufacturer of metal channel/strut framing system.
 - b. Comply with MFMA-4.
 - c. Channel Material: Use galvanized steel.
 - d. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
9. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install hangers and supports in accordance with NECA 1, BICSI ITSIMM, and BICSI N1.
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- E. Unless specifically indicated or approved by Contracting Officer or Contracting Officer's Representative, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Contracting Officer or Contracting Officer's Representative, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Equipment Support and Attachment:
 1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
 2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- I. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- J. Secure fasteners in accordance with manufacturer's recommended torque settings.
- K. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Inspect support and attachment components for damage and defects.

- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 27 05 33.13
CONDUIT FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Galvanized steel rigid metal conduit (RMC).
- B. PVC-coated galvanized steel rigid metal conduit (RMC).
- C. Flexible metal conduit (FMC).
- D. Liquidtight flexible metal conduit (LFMC).
- E. Galvanized steel electrical metallic tubing (EMT).
- F. Rigid polyvinyl chloride (PVC) conduit.
- G. Liquidtight flexible nonmetallic conduit (LFNC).
- H. Polyvinyl chloride (PVC) plastic utilities duct.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 33.13 - Conduit for Electrical Systems.
- C. Section 27 05 29 - Hangers and Supports for Communications Systems.
- D. Section 27 10 00 - Structured Cabling.
- E. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.

1.03 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC).
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S).
- C. ASTM D1002 - Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal).
- D. ASTM D1598 - Standard Test Methods for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure.
- E. ASTM D1599 - Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings.
- F. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
- G. ASTM D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
- H. ASTM F512 - Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation.
- I. BICSI ITSIMM - Information Technology Systems Installation Methods Manual (ITSIMM), 8th Edition.
- J. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition.
- K. BICSI TDMM - Telecommunications Distribution Methods Manual, 14th Edition.
- L. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- M. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT).
- N. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC).
- O. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.

- P. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit.
- Q. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit.
- R. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
- S. NEMA BI 50063 - Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations.
- T. NEMA TC 7 - Solid-Wall Coilable and Straight Electrical Polyethylene Conduit.
- U. NEMA TC 9 - Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.
- V. NFPA 70 - National Electrical Code.
- W. TIA-568.0 - Generic Telecommunications Cabling for Customer Premises.
- X. TIA-569 - Telecommunications Pathways and Spaces.
- Y. UL 1 - Flexible Metal Conduit.
- Z. UL 6 - Electrical Rigid Metal Conduit-Steel.
- AA. UL 360 - Liquid-Tight Flexible Metal Conduit.
- BB. UL 514A - Metallic Outlet Boxes.
- CC. UL 514B - Conduit, Tubing, and Cable Fittings.
- DD. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
- EE. UL 797 - Electrical Metallic Tubing-Steel.
- FF. UL 2024 - Standard for Cable Routing Assemblies and Communications Raceways.
- GG. UL 2419 - Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with actual type and quantity of cables to be installed.
 - 2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

1.06 QUALITY ASSURANCE

- A. Documents at Project Site: Maintain at project site one copy of manufacturer's instructions and shop drawings.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, TIA-569, BICSI ITSIMM, BICSI TDMM, manufacturers' instructions, and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most

restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.

- C. Underground:
 - 1. Under Slab on Grade: Use galvanized steel rigid metal conduit (RMC), PVC-coated galvanized steel rigid metal conduit (RMC), or rigid PVC conduit.
 - 2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit (RMC), PVC-coated galvanized steel rigid metal conduit (RMC), or rigid PVC conduit.
 - 3. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit (RMC), PVC-coated galvanized steel rigid metal conduit (RMC), rigid PVC conduit, or high-density polyethylene (HDPE) conduit.
 - 4. Where rigid polyvinyl chloride (PVC) conduit is provided, transition to galvanized steel rigid metal conduit (RMC) or PVC-coated galvanized steel rigid metal conduit (RMC) where emerging from underground.
- D. Embedded Within Concrete:
 - 1. Within Slab on Grade: Use galvanized steel rigid metal conduit (RMC), PVC-coated galvanized steel rigid metal conduit (RMC), or rigid PVC conduit. Embed within structural slabs only where approved by Structural Engineer.
 - 2. Where rigid polyvinyl chloride (PVC) conduit is provided, transition to galvanized steel rigid metal conduit (RMC) where emerging from concrete.
- E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit (RMC) or galvanized steel electrical metallic tubing (EMT).
- F. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).
- G. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel electrical metallic tubing (EMT) or stainless steel electrical metallic tubing (EMT).
- H. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC).
- I. Flexible Connections to Vibrating Equipment:
 - 1. Dry Locations: Use flexible metal conduit.
 - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
 - 3. Maximum Length: 6 feet unless otherwise indicated.

2.02 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70 and TIA-569.
- B. Provide conduit, fittings, supports, and accessories required for complete communications pathway.
- C. Provide products listed, classified, and labeled as suitable for purpose intended.
- D. Maximum Number of Communications Outlet Boxes per Continuous Conduit Homerun: Two.
- E. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Communications Outlet Box: 3/4-inch trade size.
- F. Where conduit size is not indicated, size to comply with NFPA 70, TIA-569, and BICSI TDMM, but not less than applicable minimum size requirements specified. Where specified standards differ, comply with most stringent.
- G. Conduit raceway for Telecommunication (Non-SIPR) cabling must be in factory finished blue conduit and be separate from all other systems. Conduit raceway for HVAC control cabling must be in factory finished green conduit and be separate from all other systems. The conduit raceway system for Fire Alarm System cabling must be in factory finished red conduit and be separate from all other systems. The conduit raceway system for CCTV, Intrusion Detection,

Access Control and Public Address System cabling must be in factory finished orange conduit and be separate from all other systems.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 - 2. Nucor Tubular Products: www.nucortubular.com/#sle.
 - 3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
 - 4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
 - 1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 - c. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - 2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
 - 3. Material: Use steel or malleable iron.
 - 4. Connectors and Couplings: Use threaded fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.
 - 5. Conduit Bodies: Use only conduit bodies specifically designed for communications cabling. Standard conduit bodies designed for electrical raceways are not permitted.
 - a. Comply with TIA-568.0 minimum bend radius requirements for fiber optic cables.

2.04 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. ABB; Ocal: www.electrification.us.abb.com/#sle.
 - 2. Calbond, a division of Atkore International www.calbond.com/#sle
 - 3. Robroy Industries: www.robroy.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil, 0.040 inch.
- D. PVC-Coated Boxes and Fittings:
 - 1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
 - 2. Nonhazardous Locations: Use boxes and fittings listed and labeled as complying with UL 514A, UL 514B, or UL 6.
 - 3. Material: Use steel or malleable iron.
 - 4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil, 0.040 inch.
 - 5. Conduit Bodies: Standard conduit bodies designed for electrical raceways are not permitted.
- E. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil, 0.015 inch.

2.05 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
 - 2. Electri-Flex Company: www.electriflex.com/#sle.
 - 3. International Metal Hose: www.metalhose.com/#sle.

4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.
- C. Fittings:
 1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.
 4. Conduit Bodies: Standard conduit bodies designed for electrical raceways are not permitted.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
 1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
 2. Electri-Flex Company: www.electriflex.com/#sle.
 3. International Metal Hose: www.metalhose.com/#sle.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
 1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.
 4. Conduit Bodies: Use only conduit bodies specifically designed for communications cabling. Standard conduit bodies designed for electrical raceways are not permitted.
 - a. Manufacturers:
 - 1) Madison Electric Products, a division of Southwire Company; _____: www.meproducts.net/#sle.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
 - b. Comply with TIA-568.0 minimum bend radius requirements for fiber optic cables.

2.07 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 2. Nucor Tubular Products: www.nucortubular.com/#sle.
 3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
 4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
- B. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
 1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.

- c. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
- d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
- 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
- 3. Material: Use steel or malleable iron.
- 4. Connectors and Couplings: Use compression/gland or set-screw type.
 - a. Do not use indenter type connectors and couplings.
- 5. Conduit Bodies: Use only conduit bodies specifically designed for communications cabling. Standard conduit bodies designed for electrical raceways are not permitted.
 - a. Manufacturers:
 - 1) Madison Electric Products, a division of Southwire Company; _____: www.meproducts.net/#sle.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
 - b. Comply with TIA-568.0 minimum bend radius requirements for fiber optic cables.

2.08 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Manufacturers:
 - 1. ABB; Carlon: www.electrification.us.abb.com/#sle.
 - 2. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 - 3. Cantex Inc: www.cantexinc.com/#sle.
 - 4. Heritage Plastics, a division of Atkore International: www.heritageplastics.com/#sle.
 - 5. JM Eagle: www.jmeagle.com/#sle.
 - 6. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage.
- C. Fittings:
 - 1. Manufacturer: Same as manufacturer of conduit to be connected.
 - 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.
 - 3. Conduit Bodies: Use only conduit bodies specifically designed for communications cabling. Standard conduit bodies designed for electrical raceways are not permitted.
 - a. Manufacturers:
 - 1) Madison Electric Products, a division of Southwire Company: www.meproducts.net/#sle.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
 - b. Comply with TIA-568.0 minimum bend radius requirements for fiber optic cables.

2.09 ACCESSORIES

- A. Inside-Plant Fabric Innerduct:
 - 1. Self-Supporting Inside-Plant Fabric Innerduct: See Section 27 05 29.
 - 2. Listed as complying with UL 2024; plenum rated.
 - 3. Products:
 - a. MaxCell Innerduct; MaxCell Premise: www.maxcell.us/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Outside-Plant Fabric Innerduct:
 - 1. Designed for installation in underground raceways.
 - 2. Detectable Innerduct:
 - a. Includes integral, magnetic detectable tracer wire, minimum 18 AWG copper.
 - b. Provide NFPA 70 required bonding of metal components in accordance with manufacturer written instructions.
 - 3. Products:
 - a. MaxCell Innerduct; MaxCell Edge: www.maxcell.us/#sle.

- b. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.
- D. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- E. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.
- F. Sealing Systems for Concrete Penetrations:
 - 1. Sleeves: Provide water stop ring or cement coating that bonds to concrete to prevent water infiltration.
 - 2. Rate for minimum of 40 psig; suitable for sealing around conduits to be installed.
- G. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.
- H. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
 - 1. Products:
 - a. Substitutions: See Section 01 60 00 - Product Requirements.
- I. Bore Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for installation within casing; furnished with roller wheels to facilitate installation, openings to facilitate grout flow, and holes for stabilization cable; suitable for casing and conduit/duct arrangement to be installed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in accordance with NECA 1, BICSI ITSIMM, and BICSI N1.
- C. Galvanized Steel Rigid Metal Conduit (RMC): Install in accordance with NECA 101.
- D. PVC-Coated Galvanized Steel Rigid Metal Conduit (RMC): Install using only tools approved by manufacturer.
- E. Galvanized Steel Electrical Metallic Tubing (EMT): Install in accordance with NECA 101.
- F. Rigid Polyvinyl Chloride (PVC) Conduit: Install in accordance with NECA 111.
- G. Conduit Routing:
 - 1. Conceal conduits unless specifically indicated to be exposed.
 - 2. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Communications rooms.
 - c. Mechanical equipment rooms.
 - d. Within joists in areas with no ceiling.
 - 3. Arrange conduit to provide no more than equivalent of two 90-degree bend(s) between pull points.
 - 4. Arrange conduit to provide no more than 100 feet between pull points.
- H. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction.
 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 4. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
 5. Use metal channel/strut with accessory conduit clamps to support multiple, parallel, surface-mounted conduits.
 6. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple, parallel, suspended conduits.
- I. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
 3. Use suitable adapters where required to transition from one type of conduit to another.
 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 6. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect cables.
 7. Secure joints and connections to provide mechanical strength and electrical continuity.
- J. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves and/or slots for penetrations as indicated or as required to facilitate installation.
 4. Conceal bends for conduit risers emerging above ground.
 5. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 6. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
 7. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 07 84 00.
- K. Underground Installation:
1. Provide trenching and backfilling; see Section 31 23 16.13.
 2. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 36 inches.
- L. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed cables or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
 3. Where conduits are subject to earth movement by settlement or frost.

M. Conduit Sealing:

1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
 - a. Where conduits enter building from outside.
 - b. Where service conduits enter building from underground distribution system.
 - c. Where conduits enter building from underground.
 - d. Where conduits may transport moisture to contact live parts.
2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
 - a. Where conduits pass from outdoors into conditioned interior spaces.
 - b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

N. Provide pull string in each empty conduit and innerduct/cell, and in each conduit where cables are to be installed by others. Leave minimum slack of 12 inches at each end.

O. Provide grounding and bonding.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- D. Correct deficiencies and replace damaged or defective conduits.

3.04 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of cables.

END OF SECTION

SECTION 27 05 36
CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Metal cable tray systems:
 - 1. Metal ladder cable tray.
 - 2. Metal channel cable tray.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 27 05 29 - Hangers and Supports for Communications Systems.
- C. Section 27 10 00 - Structured Cabling: General structured cabling system requirements.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- C. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- D. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- E. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- G. BICSI ITSIMM - Information Technology Systems Installation Methods Manual (ITSIMM), 8th Edition.
- H. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition.
- I. BICSI N3 - Planning and Installation Methods for the Bonding and Grounding of Telecommunication and ICT Systems and Infrastructure.
- J. BICSI TDMM - Telecommunications Distribution Methods Manual, 14th Edition.
- K. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- L. NECA/BICSI 607 - Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings.
- M. NEMA BI-50016 - Cable Tray Installation Guidelines.
- N. NEMA BI 50015 - Metal Cable Tray Systems.
- O. NFPA 70 - National Electrical Code.
- P. NFPA 101 - Life Safety Code.
- Q. TIA-569 - Telecommunications Pathways and Spaces.
- R. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
- S. UL 2024 - Standard for Cable Routing Assemblies and Communications Raceways.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

1. Coordinate arrangement of cable tray with structural members, ductwork, piping, equipment and other potential conflicts. Coordinate work to avoid installation of obstructions within cable tray required clearances.
2. Coordinate arrangement of cable tray with dimensions and clearance requirements of actual products to be installed.
3. Coordinate work with placement of supports and anchors required for mounting.
4. Notify of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cable tray system components and accessories. Include dimensions, materials, fabrication details, finishes, and span/load ratings.
- C. Shop Drawings: Include dimensioned plan views and sections indicating proposed cable tray routing, required clearances, and locations and details of supports, fittings, building element penetrations, and equipment connections.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

- A. See Section 27 10 00 for additional quality assurance requirements.
- B. Comply with NFPA 70.
- C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Handle products carefully to avoid damage to finish.

PART 2 PRODUCTS

2.01 CABLE TRAY SYSTEM - GENERAL REQUIREMENTS

- A. Provide new cable tray system consisting of required components, fittings, supports, and accessories, as necessary for complete system.
- B. Provide products listed, classified, and labeled as suitable for purpose intended.
- C. Do not use cable tray for applications other than as permitted by NFPA 70 and product listing/classification.
- D. Provide cable tray system and associated components suitable for use at indicated span/load ratings under service conditions at installed location.
- E. Unless otherwise indicated, specified span/load ratings are based on safety factor of 1.5 and working load only (i.e., no additional concentrated static load), with ratings for metal cable tray systems in accordance with NEMA BI 50015.
- F. Unless otherwise indicated, specified load/fill depths and inside widths are nominal values, with values for metal cable tray systems in accordance with NEMA BI 50015 including applicable allowable tolerances.

2.02 METAL CABLE TRAY SYSTEMS

- A. Manufacturers:
 1. ABB, Inc: www.new.abb.com/#sle.
 2. Cablofil, a brand of Legrand North America, Inc: www.legrand.us/cablofil/#sle.
 3. Cope, a brand of Atkore International Inc: www.copecabletray.com/#sle.
- B. Comply with NEMA BI 50015.

- C. Material/Finishes:
 - 1. Mill-Galvanized Before Fabrication (Pre-Galvanized) Steel: Comply with ASTM A653/A653M, G90 coating.
- D. Metal Ladder Cable Tray:
 - 1. Material: Mill-galvanized before fabrication (pre-galvanized) steel.
 - 2. Load/Fill Depth: 5 inches.
 - 3. Span/Load Rating: As indicated on drawings.
 - 4. Rung Spacing: 9 inches on center for straight lengths.
 - 5. Inside Width: As indicated on drawings.
 - 6. Inside Radius of Fittings: 12 inches.
- E. Metal Channel Cable Tray:
 - 1. Material: Mill-galvanized before fabrication (pre-galvanized) steel.
 - 2. Bottom Type: Ventilated bottom.
 - 3. Tray Depth: 1-3/4 inches.
 - 4. Span/Load Rating: As indicated on drawings.
 - 5. Tray Width: 3 inches.
 - 6. Inside Radius of Fittings: 12 inches.

2.03 ACCESSORIES

- A. Cable Tray Cover Expansion Clamps:
 - 1. Provide heavy-duty wrap around style clamps.
- B. Inside-Plant Fabric Innerduct:
 - 1. Listed as complying with UL 2024; plenum rated.
 - 2. Products:
 - a. MaxCell Innerduct; MaxCell Premise: www.maxcell.us/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Metal Cable Tray: Perform factory design tests in accordance with NEMA BI 50015, including electrical continuity and load testing.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage cable tray system has been completed.
- B. Verify field measurements.
- C. Verify dimensions and span/load ratings of cable tray system components.
- D. Verify that mounting surfaces are ready to receive cable tray and associated supports.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install cable tray system in accordance with the following. Where requirements differ, comply with most stringent.
 - 1. BICSI ITSIMM (technology systems).
 - 2. BICSI N1 (cabling infrastructure).
 - 3. NECA 1 (general workmanship).
 - 4. NEMA BI-50016 (cable tray).
- C. Unless otherwise indicated, arrange cable tray to be parallel or perpendicular to building lines.
- D. Arrange cable tray to provide required clearances and maintain cable access.

1. Maintain minimum clearance of 3 inches between bottom of cable tray and top of suspended ceilings, unless otherwise indicated or required by authorities having jurisdiction.
 2. Minimum Clearance Above and Adjacent to Cable Tray: 12 inches.
 3. Maintain recommended separation from sources of electromagnetic interference (EMI) greater than 5 kVA in accordance with BICSI ITSIMM and BICSI TDMM.
- E. Install cable tray plumb and level, with sections aligned and with horizontal runs at specified elevation.
- F. Cable Tray Movement Provisions:
1. Provide expansion fittings where cable tray is subject to movement, including but not limited to:
 - a. Where cable tray crosses structural joints intended for expansion.
 - b. Long straight cable tray runs in accordance with NEMA BI-50016.
 2. Use expansion guides in lieu of hold-down clamps where prescribed in NEMA BI-50016.
 3. Set gaps for expansion fittings in accordance with NEMA BI-50016.
- G. Cable Provisions:
1. Use fixed barrier strips to maintain separation of cables as indicated and as required by NFPA 70.
 2. Use drop-out fittings or bushings where cables exit cable tray as required to maintain minimum cable bending radius.
 3. Use cable support fittings for long vertical cable tray runs with heavy cables.
- H. Provide end closures at unconnected ends of cable tray runs.
- I. Cable Tray Support:
1. Use manufacturer's recommended hangers and supports, located in accordance with NEMA BI-50016, BICSI ITSIMM, and manufacturer's requirements, but not exceeding specified span unless otherwise approved by Engineer. Provide required support and attachment where not furnished by cable tray manufacturer.
 2. Provide support within 24 inches of each side of connection to a bend, tee, or cross in accordance with TIA-569, unless otherwise approved by Engineer.
 3. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- J. Grounding and Bonding Requirements:
1. Install cable tray grounding in accordance with the following. Where requirements differ, comply with the most stringent.
 - a. BICSI ITSIMM (technology systems).
 - b. BICSI N3 (cabling infrastructure).
 - c. BICSI TDMM (telecommunications distribution methods).
 - d. NECA/BICSI 607 (telecommunications bonding and grounding).
 - e. NEMA BI-50016 (cable tray).
 - f. TIA-607 (generic telecommunications bonding and grounding).
 2. Metal Cable Tray Systems: Use suitable bonding jumpers or classified cable tray connectors to provide electrical continuity. Do not use classified cable tray connectors where cable tray sections have been modified, such as being bent, cut, or reshaped.
 3. Provide suitable bonding conductor in each metal cable tray. Do not use cable tray as sole bonding conductor.
 - a. Bonding Conductor for Galvanized Steel Cable Tray: Use bare or insulated copper conductor.
 - b. Minimum Bonding Conductor Size:
 - 1) Conductor Lengths up to Up to 100 ft: 6 AWG.
 - 2) Conductor lengths greater than 100 ft: Size in accordance with BICSI TDMM.

- c. Bond cable tray bonding conductor to each metal cable tray section using suitable listed ground clamps. Separate bonding jumpers are not required where properly bonded cable tray bonding conductor provides equivalent continuity.
- 4. Metal cable tray system may be used as sole bonding conductor only where all conditional requirements of NFPA 70 are met, including but not limited to:
 - a. Installation must be in qualifying facility with suitable maintenance and supervision as determined by authorities having jurisdiction.
 - b. Cable tray system must be galvanized steel or aluminum (as specified) and classified as equipment bonding conductor (stainless steel cable tray is not permitted for use as bonding conductor).
 - c. Cable tray must meet minimum cross-sectional area requirements.
- 5. Bond cable tray and/or cable tray bonding conductor to Primary Bonding Busbar (PBB) or Secondary Bonding Busbar (SBB) at each termination location.
- K. Conduit Termination:
 - 1. Use listed cable tray conduit clamps (evaluated for bonding connection) to terminate conduits at cable tray.
 - 2. Provide insulating bushing at conduit termination to protect cables.
 - 3. Provide independent support for conduit.
- L. Cable Installation:
 - 1. Install cables in accordance with the following. Where requirements differ, comply with most stringent.
 - a. BICSI ITSIMM (technology systems).
 - b. BICSI N1 (cabling infrastructure).
 - c. NEMA BI-50016 (cable tray).
 - 2. Use appropriate cable pulling tools, applied to prevent excessive force on cable tray system and maintain minimum cable bending radius.
 - 3. Use cable clamps or cable ties to fasten conductors/cables to vertical and horizontal runs of cable tray.
 - a. Distance Between Fastening Points for Vertical Runs: 18 inches.
 - b. Distance Between Fastening Points for Horizontal Runs: As required to maintain spacing and confine conductor/cable within cable fill area.
- M. Penetrations: Install firestopping to preserve fire resistance rating of building elements.
 - 1. See Section 07 84 00 for additional requirements.
- N. Install cable tray covers where indicated and as follows:

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Inspect cable tray system for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective cable tray system components.

3.04 ADJUSTING

- A. Adjust tightness of mechanical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- A. Remove dirt and debris from cable tray.
- B. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.06 PROTECTION

- A. Protect cable tray system from subsequent construction operations.

END OF SECTION

**SECTION 27 10 00
STRUCTURED CABLING**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Communications system design requirements.
- B. Communications pathways.
- C. Copper cable and terminations.
- D. Fiber optic cable and interconnecting devices.
- E. Communications equipment room fittings.
- F. Communications outlets.
- G. Communications grounding and bonding.
- H. Communications identification.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 33.16 - Boxes for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products.
- E. Section 26 27 26 - Wiring Devices.
- F. Section 27 05 29 - Hangers and Supports for Communications Systems.
- G. Section 27 05 33.13 - Conduit for Communications Systems.
- H. Section 33 71 19 - Electrical Underground Ducts, Ductbanks, and Manholes.

1.03 REFERENCE STANDARDS

- A. ASTM D1002 - Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal).
- B. ASTM D1598 - Standard Test Methods for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure.
- C. ASTM D1599 - Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings.
- D. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition.
- E. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment.
- F. FM (AG) - FM Approval Guide.
- G. ICEA S-83-596 - Indoor Optical Fiber Cable.
- H. ICEA S-90-661 - Category 3 and 5E Individually Unshielded Twisted Pairs, Indoor Cables (With or Without an Overall Shield) for Use in General Purpose and LAN Communication Wiring Systems.
- I. NFPA 70 - National Electrical Code.
- J. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices.
- K. TIA-492AAAA - Detail Specification for 62.5-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
- L. TIA-492AAAB - Detail Specification for 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.

- M. TIA-492AAAC - Detail Specification for 850-nm Laser-Optimized, 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
- N. TIA-492AAD - Detail Specification for 850-nm Laser- Optimized, 50-µm Core Diameter/125-µm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers Suitable for Manufacturing OM4 Cabled Optical Fiber.
- O. TIA-492CAA - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers.
- P. TIA-492CAAB - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak.
- Q. TIA-526-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 Edition 2: Fibre-Optic Communications Subsystem Test Procedures – Part 4-2: Installed Cable Plant – Single-Mode Attenuation and Optical Return Loss Measurement.
- R. TIA-526-14 - Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant; IEC 61280-4.1 Edition 3.1, Fiber Optic Communications Subsystem Test Procedures- Part 4-1: Installed Cable Plant- Multimode Attenuation Measurement.
- S. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set.
- T. TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
- U. TIA-568.3 - Optical Fiber Cabling and Components Standard.
- V. TIA-569 - Telecommunications Pathways and Spaces.
- W. TIA-598 - Optical Fiber Cable Color Coding.
- X. TIA-606 - Administration Standard for Telecommunications Infrastructure.
- Y. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
- Z. UL 444 - Communications Cables.
- AA. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
- BB. UL 1651 - Fiber Optic Cable.
- CC. UL 1863 - Communications-Circuit Accessories.
- DD. UL 2024 - Standard for Cable Routing Assemblies and Communications Raceways.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. Evidence of qualifications for installer.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- E. Field Test Reports.
- F. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
 - 1. Record actual locations of outlet boxes and distribution frames.
 - 2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.

3. Identify distribution frames and equipment rooms by room number on drawings.
- G. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
 1. Employing a BICSI Registered Communications Distribution Designer (RCDD).
 2. Supervisors and installers factory certified by manufacturers of products to be installed.
 3. Employing BICSI Registered Cabling Installation Technicians (RCIT) for supervision of all work.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep stored products clean and dry.

1.08 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a 2 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN

- A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
 1. Comply with TIA-568 (SET) (cabling) and TIA-569 (pathways) (commercial standards).
 2. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
 3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
 4. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.
- B. Main Distribution Frame (MDF): Centrally located support structure for terminating horizontal cables that extend to telecommunications outlets, functioning as point of presence to external service provider.
 1. Locate main distribution frame as indicated on the drawings.
 2. Capacity: As required to terminate all cables required by design criteria plus minimum 25 percent spare space.
- C. Intermediate Distribution Frames (IDF): Support structures for terminating horizontal cables that extend to telecommunications outlets.
 1. Locate intermediate distribution frames as indicated on the drawings.
- D. Backbone Cabling: Cabling, pathways, and terminal hardware connecting intermediate distribution frames (IDF's) with main distribution frame (MDF), wired in star topology with main distribution frame at center hub of star.
- E. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

2.02 PATHWAYS

- A. Conduit: See section 27 05 33.13.
- B. Underground Service Entrance: Rigid polyvinyl chloride (PVC) conduit, Schedule 40.

- C. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
 - 1. Products:
 - a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: www.holdrite.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 COPPER CABLE AND TERMINATIONS

- A. Manufacturers:
 - 1. CommScope: www.commscope.com/#sle.
 - 2. General Cable Technologies Corporation: www.generalcable.com/#sle.
 - 3. Siemon Company: www.siemon.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Copper Backbone Cable:
 - 1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2, ICEA S-90-661, and listed and labeled as complying with UL 444; arranged in 25-pair binder groups.
 - 2. Cable Capacity: Quantity of pairs as indicated on drawings.
 - 3. Cable Applications:
 - a. Plenum Applications: Use listed NFPA 70 Type CMP plenum cable.
 - b. Riser Applications: Use listed NFPA 70 Type CMR riser cable or Type CMP plenum cable.
- C. Copper Horizontal Cable:
 - 1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2 and listed and labeled as complying with UL 444.
 - 2. Cable Type - Voice and Data: TIA-568.2 Category 6 UTP (unshielded twisted pair); 23 AWG.
 - 3. Cable Capacity: 4-pair.
 - 4. Cable Applications: Use listed NFPA 70 Type CMP plenum cable unless otherwise indicated.
 - 5. Cable Jacket Color - Voice and Data Cable: Blue.
 - 6. Product(s):
 - a. CommScope; SYSTIMAX Twisted Pair Cables; GigaSPEED XL Category 6 U/UTP Cable: www.commscope.com/#sle.
 - b. CommScope; Uniprise Twisted Pair Cables; CS34 Series Category 6 U/UTP Cable: www.commscope.com/#sle.
- D. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.
- E. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.
 - 1. Performance: 500 mating cycles.
 - 2. Voice and Data Jacks: 8-position modular jack, color-coded for both T568A and T568B wiring configurations.
- F. Copper Patch Cords:
 - 1. Description: Factory-fabricated 4-pair cable assemblies with 8-position modular connectors terminated at each end.
 - 2. Patch Cords for Patch Panels:
 - a. Quantity: One for each pair of patch panel ports.
 - b. Length: 3 feet.
 - 3. Patch Cords for Work Areas:
 - a. Quantity: One for each work area outlet port.
 - b. Length: 9 feet.

4. Product(s):
 - a. CommScope; SYSTIMAX Category 6 U/UTP Patch Cords: www.commscope.com/#sle.
 - b. CommScope; Uniprise Category 6 U/UTP Patch Cords: www.commscope.com/#sle.

2.04 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

- A. Manufacturers:
 1. CommScope: www.commscope.com/#sle.
 2. General Cable Technologies Corporation: www.generalcable.com/#sle.
 3. Siemon Company: www.siemon.com/#sle.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Fiber Optic Backbone Cable:
 1. Description: Tight buffered, non-conductive fiber optic cable complying with TIA-568.3, TIA-598, ICEA S-83-596 and listed as complying with UL 444 and UL 1651.
 2. Cable Type: Multimode, laser-optimized 50/125 um (OM4) complying with TIA-492AAAD.
 3. Cable Capacity: Quantity of fibers as indicated on drawings.
 4. Cable Applications:
 - a. Plenum Applications: Use listed NFPA 70 Type OFNP plenum cable.
 - b. Riser Applications: Use listed NFPA 70 Type OFNR riser cable or Type OFNP plenum cable.
 5. Cable Jacket Color:
 - a. Laser-Optimized Multimode Fiber (OM3/OM4): Aqua.
 6. Product(s):
 - a. CommScope Fiber Optic Cables; LazrSPEED 550 OM4 Multimode Fiber: www.commscope.com/#sle.
- C. Fiber Optic Interconnecting Devices:
 1. Connector Type: Type LC.
 2. Connector Performance: 500 mating cycles, when tested in accordance with TIA-455-21.
 3. Maximum Attenuation/Insertion Loss: 0.3 dB.
 4. Product(s):
 - a. CommScope Fiber Optic Connectors; QWIK II-LC Fiber Connectors: www.commscope.com/#sle.
- D. Fiber Optic Patch Cords:
 1. Description: Factory-fabricated 2-fiber cable assemblies with suitable connectors at each end.
 2. Patch Cords for Patch Panels:
 - a. Quantity: One for each pair of patch panel ports.
 - b. Length: 3 feet.
 3. Product(s):
 - a. CommScope Fiber Optic Patch Cords; TeraSpeed Fiber Patch Cords: www.commscope.com/#sle.

2.05 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

- A. Copper Cross-Connection Equipment:
 1. Manufacturers:
 - a. CommScope; _____: www.commscope.com/#sle.
 - b. Siemon Company; _____: www.siemon.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Product(s):
 - a. CommScope; SYSTIMAX Copper Panels; 360-IPR-1100-XX Series Patch Panels: www.commscope.com/#sle.
 - b. CommScope; Uniprise Copper Panels; UNP-XX-DM Series Patch Panels: www.commscope.com/#sle.

- B. Fiber Optic Cross-Connection Equipment:
 - 1. Manufacturers:
 - a. CommScope: www.commscope.com/#sle.
 - b. Siemon Company: www.siemon.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Patch Panels for Fiber Optic Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
 - a. Adapters: As specified above under FIBER OPTIC CABLE AND INTERCONNECTING DEVICES; maximum of 24 duplex adaptors per standard panel width.
 - b. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
 - c. Provide incoming cable strain relief and routing guides on back of panel.
 - d. Provide rear cable management tray at least 8 inches deep with removable cover.
 - e. Provide dust covers for unused adapters.
 - 3. Product(s):
 - a. CommScope; SYSTIMAX Fiber Panels; HD Series Patch Panels: www.commscope.com/#sle.
 - b. CommScope; Uniprise Fiber Panels; SD Series Patch Panels: www.commscope.com/#sle.
- C. Backboards: Interior grade plywood without voids, 3/4 inch thick; UL-labeled fire-retardant.
 - 1. Size: As indicated on drawings.
 - 2. Do not paint over UL label.
- D. Equipment Frames, Racks and Cabinets:
 - 1. Manufacturers:
 - a. AtlasIED: www.atlasied.com/#sle.
 - b. CommScope: www.commscope.com/#sle.
 - c. Siemon Company: www.siemon.com/#sle.
 - 2. Floor Mounted Racks: Aluminum or steel construction with corrosion resistant finish; vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug.
 - 3. Freestanding Cabinets: Front and rear doors with locks; removable side panels with locks; vented top and rear door; adjustable leveling feet; cable access in roof and base; grounding bar.
 - a. Roof mounted fan, capacity.
 - 4. Cabinets: Steel construction with corrosion resistant finish.
 - 5. Locks: Keyed alike.
 - 6. Products:
 - a. AtlasIED Floor Racks; FMA Series: www.atlasied.com/#sle.
 - b. AtlasIED Wall Racks; WMA Series: www.atlasied.com/#sle.
 - c. CommScope; Two-Post Equipment Racks (Relay Racks): www.commscope.com/#sle.
- E. Cable Management:
 - 1. Manufacturers:
 - a. CommScope: www.commscope.com/#sle.
 - b. Siemon Company: www.siemon.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Product(s):
 - a. CommScope Cable Runway: www.commscope.com/#sle.
 - b. CommScope Horizontal/Vertical Cable Managers; HCM-SS-XX-XX/VCM-DS-XX-XX Series: www.commscope.com/#sle.
 - c. CommScope FiberGuide Raceway: www.commscope.com/#sle.

2.06 COMMUNICATIONS OUTLETS

- A. Manufacturers:
 - 1. CommScope: www.commscope.com/#sle.
 - 2. Siemon Company: www.siemon.com/#sle.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Outlet Boxes: Comply with Section 26 05 33.16.
 - 1. Provide depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
 - 2. Minimum Size, Unless Otherwise Indicated:
 - a. Data or Combination Voice/Data Outlets: 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.
- C. Wall Plates:
 - 1. Comply with system design standards and UL 514C.
 - 2. Accepts modular jacks/inserts.
 - 3. Wall Plate Material/Finish - Flush-Mounted Outlets: Match wiring device and wall plate finishes specified in Section 26 27 26.

2.07 GROUNDING AND BONDING COMPONENTS

- A. Comply with TIA-607.
- B. Comply with Section 26 05 26.

2.08 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606.

2.09 ACCESSORIES

- A. Inside-Plant Fabric Innerduct:
 - 1. Listed as complying with UL 2024; plenum rated.
 - 2. Products:
 - a. MaxCell Innerduct; MaxCell Premise: www.maxcell.us/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Outside-Plant Fabric Innerduct:
 - 1. Designed for installation in underground raceways.
 - 2. Detectable Innerduct:
 - a. Includes integral, magnetic detectable tracer wire, minimum 18 AWG copper.
 - b. Provide NFPA 70 required bonding of metal components in accordance with manufacturer written instructions.
 - 3. Products:
 - a. MaxCell Innerduct; MaxCell Edge: www.maxcell.us/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.10 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Factory test cables according to TIA-568 (SET).

PART 3 EXECUTION**3.01 INSTALLATION - GENERAL**

- A. Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569 (pathways), TIA-607 (grounding and bonding), BICSI N1, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
- B. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.
- C. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

3.02 INSTALLATION OF PATHWAYS

- A. Install pathways with the following minimum clearances:
 - 1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
 - 2. 12 inches from power conduits and cables and panelboards.
 - 3. 5 inches from fluorescent and high frequency lighting fixtures.
 - 4. 6 inches from flues, hot water pipes, and steam pipes.
- B. Outlet Boxes:
 - 1. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of telecommunications outlets provided under this section.
 - a. Mounting Heights: Unless otherwise indicated, as follows:
 - 1) Telephone and Data Outlets: 18 inches above finished floor.
 - b. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 - c. Provide minimum of 24 inches horizontal separation between flush mounted outlet boxes installed on opposite sides of fire rated walls.
 - d. Unless otherwise indicated, provide separate outlet boxes for line voltage and low voltage devices.
 - e. Locate outlet boxes so that wall plate does not span different building finishes.
 - f. Locate outlet boxes so that wall plate does not cross masonry joints.

3.03 INSTALLATION OF EQUIPMENT AND CABLING

- A. Cabling:
 - 1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
 - 2. Do not over-cinch or crush cables.
 - 3. Do not exceed manufacturer's recommended cable pull tension.
 - 4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
- B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
 - 1. At Distribution Frames: 120 inches.
 - 2. At Outlets - Copper: 12 inches.
 - 3. At Outlets - Optical Fiber: 39 inches.
- C. Copper Cabling:
 - 1. Category 6 and/or industry standard: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
 - 2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
 - 3. Use T568B wiring configuration.
- D. Fiber Optic Cabling:
 - 1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
 - 2. Support vertical cable at intervals as recommended by manufacturer.
- E. Floor-Mounted Racks and Enclosures: Permanently anchor to floor in accordance with manufacturer's recommendations.
- F. Identification:
 - 1. Use wire and cable markers to identify cables at each end.
 - 2. Use manufacturer-furnished label inserts, identification labels, or engraved wallplate to identify each jack at communications outlets with unique identifier.
 - 3. Use identification nameplate to identify cross-connection equipment, equipment racks, and cabinets.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Comply with inspection and testing requirements of specified installation standards.
- C. Visual Inspection:
 - 1. Inspect cable jackets for certification markings.
 - 2. Inspect cable terminations for color coded labels of proper type.
 - 3. Inspect outlet plates and patch panels for complete labels.
- D. Testing - Copper Cabling and Associated Equipment:
 - 1. Test backbone cables after termination but before cross-connection.
 - 2. Test backbone cables for DC loop resistance, shorts, opens, intermittent faults, and polarity between connectors and between conductors and shield, if cable has overall shield.
 - 3. Category 5e and Above Links: Perform tests for wire map, length, attenuation, NEXT, and propagation delay.
- E. Testing - Fiber Optic Cabling:
 - 1. Backbone: Perform optical fiber end-to-end attenuation test using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures; perform verification acceptance tests and factory reel tests.
 - 2. Multimode Backbone: Perform tests in accordance with TIA-526-14.
 - 3. Single Mode Backbone: Perform tests in accordance with TIA-526-7.
 - 4. Links: Perform optical fiber end-to-end attenuation tests and field reel tests.
- F. Final Testing: After all work is complete, including installation of telecommunications outlets, and telephone dial tone service is active, test each voice jack for dial tone.

END OF SECTION

**SECTION 28 46 00
FIRE DETECTION AND ALARM**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Fire alarm system design and installation, including all components, wiring, and conduit.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping: Materials and methods for work to be performed by this installer.
- B. Section 14 21 00 - Electric Traction Elevators: Elevator systems monitored and controlled by fire alarm system.
- C. Section 21 13 00 - Fire-Suppression Sprinkler Systems: Supervisory, alarm, and actuating devices installed in sprinkler system.
- D. Section 23 33 00 - Air Duct Accessories: Smoke dampers monitored and controlled by fire alarm system.

1.03 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines.
- B. ADA Standards - 2010 ADA Standards for Accessible Design.
- C. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits.
- D. NFPA 70 - National Electrical Code.
- E. NFPA 72 - National Fire Alarm and Signaling Code.
- F. NFPA 76 - Standard for the Fire Protection of Telecommunications Facilities.
- G. NFPA 101 - Life Safety Code.
- H. UL 268 - Standard for Smoke Detectors for Fire Alarm Systems.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Proposal Documents: Submit the following with cost/time proposal:
 - 1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
- C. Evidence of designer qualifications.
- D. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
 - 1. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
- E. Evidence of installer qualifications.
- F. Inspection and Test Reports:
 - 1. Submit inspection and test plan prior to closeout demonstration.
 - 2. Submit documentation of satisfactory inspections and tests.
- G. Closeout Documents:
 - 1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
 - 2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.

3. Certificate of Occupancy.

1.05 QUALITY ASSURANCE

- A. Copies of Design Criteria Documents: Maintain at the project site for the duration of the project, bound together, an original copy of NFPA 72, the relevant portions of applicable codes, and instructions and guidelines of authorities having jurisdiction; deliver to Government upon completion.
- B. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.
- C. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Fire Alarm Control Units and Accessories - Basis of Design: Monaco.
- B. Initiating Devices and Notification Appliances:
 - 1. Provide initiating devices and notification appliances made by the same manufacturer, where possible.

2.02 FIRE ALARM SYSTEM

- A. Fire Alarm System: Provide a new automatic fire detection and alarm system:
 - 1. Provide all components necessary, regardless of whether shown in Contract Documents or not.
 - 2. Protected Premises: Entire building shown on drawings.
 - 3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
 - a. ADA Standards.
 - b. The requirements of the State Fire Marshal.
 - c. The requirements of the local authority having jurisdiction.
 - d. Applicable local codes.
 - e. Contract Documents (drawings and specifications).
 - f. NFPA 101.
 - g. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
 - 4. Voice Notification: Provide emergency voice/alarm communications with multichannel capability; digital.
 - 5. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
- B. Circuits:
 - 1. Initiating Device Circuits (IDC): Class B, Style A.
 - 2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
 - 3. Notification Appliance Circuits (NAC): Class B, Style W.

- C. Spare Capacity:
 - 1. Initiating Device Circuits: Minimum 25 percent spare capacity.
 - 2. Speaker Amplifiers: Minimum 25 percent spare capacity.
 - 3. Fire Alarm Control Units: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.
- D. Power Sources:
 - 1. Primary: Dedicated branch circuits of the facility power distribution system.
 - 2. Secondary: Storage batteries.
 - 3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.

2.03 FIRE SAFETY SYSTEMS INTERFACES

- A. Elevators:
 - 1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.

2.04 COMPONENTS

- A. General:
 - 1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
- B. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.
- C. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
 - 1. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a building; rated to protect applicable equipment; for 24 V(dc) maximum dc clamping voltage of 36 V(dc), line-to-ground, and 72 V(dc), line-to-line.
 - 2. Signaling Line Circuits: Provide surge protection at each point where circuit exits or enters a building, rated to protect applicable equipment.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and Contract Documents.

3.02 INSPECTION AND TESTING FOR COMPLETION

- A. Notify owner 7 days prior to beginning completion inspections and tests.
- B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- E. Provide all tools, software, and supplies required to accomplish inspection and testing.
- F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- G. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
- H. Diagnostic Period: After successful completion of inspections and tests, Operate system in normal mode for at least 14 days without any system or equipment malfunctions.
 - 1. Record all system operations and malfunctions.
 - 2. If a malfunction occurs, start diagnostic period over after correction of malfunction.

3.03 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to owner.
 - 1. Be prepared to conduct any of the required tests.

3.04 MAINTENANCE

- A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

END OF SECTION

**SECTION 31 22 00
GRADING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Removal and storage of topsoil.
- B. Rough grading the site for site structures.
- C. Finish grading.

1.02 RELATED REQUIREMENTS

- A. Section 31 23 16 - Excavation.
- B. Section 31 23 16.13 - Trenching: Trenching and backfilling for utilities.
- C. Section 31 23 23 - Fill: Filling and compaction.
- D. Section 32 92 19 - Seeding: Finish ground cover.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 01 22 00 - Unit Prices, for general requirements relating to unit prices for this work.

1.04 SUBMITTALS

- A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Topsoil: See Section 31 23 23.
- B. Other Fill Materials: See Section 31 23 23.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that survey bench mark and intended elevations for the Work are as indicated.
- B. Verify the absence of standing or ponding water.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Stake and flag locations of known utilities.
- C. Notify utility company to remove and relocate utilities.
- D. Provide temporary means and methods to remove all standing or ponding water from areas prior to grading.
- E. Protect site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.
- F. Protect trees to remain by providing substantial fencing around entire tree at the outer tips of its branches; no grading is to be performed inside this line.
- G. Protect plants, lawns, rock outcroppings, and other features to remain as a portion of final landscaping.

3.03 ROUGH GRADING

- A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.
- B. Do not remove topsoil when wet.
- C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.

- D. Do not remove wet subsoil , unless it is subsequently processed to obtain optimum moisture content.
- E. When excavating through roots, perform work by hand and cut roots with sharp axe.
- F. See Section 31 23 23 for filling procedures.
- G. Benching Slopes: Horizontally bench existing slopes greater than 1:4 to key fill material to slope for firm bearing.
- H. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.
- I. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack surface water control.

3.04 SOIL REMOVAL

- A. Stockpile excavated topsoil on site.
- B. Stockpile topsoil to be re-used on site; remove remainder from site.
- C. Remove excavated topsoil from site.
- D. Stockpile excavated subsoil on site.
- E. Stockpile subsoil to be re-used on site; remove remainder from site.
- F. Remove excavated subsoil from site.
- G. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.

3.05 FINISH GRADING

- A. Before Finish Grading:
 - 1. Verify building and trench backfilling have been inspected.
 - 2. Verify subgrade has been contoured and compacted.
- B. Remove debris, roots, branches, stones, in excess of 1/2 inch in size. Remove soil contaminated with petroleum products.
- C. Where topsoil is to be placed, scarify surface to depth of 3 inches.
- D. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches.
- E. Place topsoil in areas where seeding are indicated.
- F. Place topsoil in areas indicated.
- G. Place topsoil where required to level finish grade.
- H. Place topsoil to thickness as indicated.
- I. Place topsoil to nominal depth of 6 inches.
- J. Place topsoil to the following compacted thicknesses:
 - 1. Areas to be Seeded with Grass: 6 inches.
- K. Place topsoil during dry weather.
- L. Remove roots, weeds, rocks, and foreign material while spreading.
- M. Near plants spread topsoil manually to prevent damage.
- N. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.
- O. Lightly compact placed topsoil.
- P. Maintain stability of topsoil during inclement weather. Replace topsoil in areas where surface water has eroded thickness below specifications.

3.06 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) from required elevation.

- B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch).

3.07 REPAIR AND RESTORATION

- A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.
- B. Trees to Remain: If damaged due to this work, trim broken branches and repair bark wounds; if root damage has occurred, obtain instructions from Contracting Officer or Contracting Officer's Representative as to remedy.
- C. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size.

3.08 FIELD QUALITY CONTROL

- A. See Section 31 23 23 for compaction density testing.

3.09 CLEANING

- A. Remove unused stockpiled topsoil. Grade stockpile area to prevent standing water.
- B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION

**SECTION 31 23 16
EXCAVATION****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Excavating for building volume below grade, footings, pile caps, slabs-on-grade, paving, site structures, and utilities within the building.
- B. Trenching for utilities outside the building to utility main connections.
- C. Temporary excavation support and protection systems.

1.02 RELATED REQUIREMENTS

- A. Geotechnical report; bore hole locations and findings of subsurface materials.
- B. Section 01 57 13 - Temporary Erosion and Sediment Control: Slope protection and erosion control.
- C. Section 01 70 00 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring. General requirements for dewatering of excavations and water control.
- D. Section 02 41 00 - Selective Demolition: Shoring and underpinning existing structures.
- E. Section 21 05 53 - Identification for Fire Suppression Piping and Equipment: Underground warning tapes at underground fire suppression lines.
- F. Section 22 05 53 - Identification for Plumbing Piping and Equipment: Underground warning tapes at underground plumbing lines.
- G. Section 23 05 53 - Identification for HVAC Piping and Equipment: Underground warning tapes at underground HVAC lines.
- H. Section 26 05 53 - Identification for Electrical Systems: Underground warning tapes at underground electrical lines.
- I. Section 31 22 00 - Grading: Soil removal from surface of site.
- J. Section 31 22 00 - Grading: Grading.
- K. Section 31 23 16.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.
- L. Section 31 23 16.26 - Rock Removal: Removal of rock during excavating.
- M. Section 31 23 23 - Fill: Fill materials, backfilling, and compacting.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 01 22 00 - Unit Prices, for general requirements applicable to unit prices for excavation.
- B. See Section 31 23 23 for measurement and payment provisions related to fill.

1.04 REFERENCE STANDARDS

- A. 29 CFR 1926 - Safety and Health Regulations for Construction.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Temporary Support and Excavation Protection Plan.
- C. Project Record Documents: Record drawings at project closeout according to 01 70 00 - Execution and Closeout Requirements. Show locations of installed support materials left in place, including referenced locations and depths, on drawings.
- D. Field Quality Control Submittals: Document visual inspection of load-bearing excavated surfaces.

1.06 QUALITY ASSURANCE

- A. Temporary Support and Excavation Protection Plan:
 - 1. Indicate sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property.
 - 2. Bracing and shoring design to meet requirements of OSHA's Excavation Standard, 29 CFR 1926, Subpart P.
- B. Designer Qualifications: For design of temporary shoring and bracing, employ a Professional Engineer experienced in design of this type of work and licensed in the Commonwealth of Pennsylvania.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Bedding and Fill to Correct Over-Excavation:
 - 1. See Section 31 23 23 for bedding and corrective fill materials at general excavations.
 - 2. See Section 31 23 16.13 for bedding and corrective fill materials at utility trenches.
- B. Underground Warning Tapes:
 - 1. See Section 21 05 53 for underground warning tapes at underground fire suppression lines.
 - 2. See Section 22 05 53 for underground warning tapes at underground plumbing lines.
 - 3. See Section 23 05 53 for underground warning tapes at underground HVAC lines.
 - 4. See Section 26 05 53 for underground warning tapes at underground electrical lines.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that survey bench mark and intended elevations for the work are as indicated.
- B. Survey existing adjacent structures and improvements and establish exact elevations at fixed points to act as benchmarks.
 - 1. Resurvey benchmarks during installation of excavation support and protection systems and notify Government if any changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.
- C. Determine the prevailing groundwater level prior to excavation. If the proposed excavation extends less than 1 foot into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by Contracting Officer or Contracting Officer's Representative. If the proposed excavation extends more than 1 foot into the prevailing groundwater, control groundwater intrusion with a comprehensive dewatering procedures, or as directed by Geotechnical Engineer.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect utilities that remain and protect from damage.
- C. Notify utility company to remove and relocate utilities.
- D. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- E. Protect plants, lawns, rock outcroppings, and other features to remain.
- F. Grade top perimeter of excavation to prevent surface water from draining into excavation. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by Contracting Officer or Contracting Officer's Representative.
- G. See Sections 01 70 00 and 02 41 00 for underpinning and shoring of adjacent structures that could be damaged by excavating work.

3.03 TEMPORARY EXCAVATION SUPPORT AND PROTECTION

- A. Leave excavation support and protection systems, used as formwork or within 10 feet of existing foundations, permanently in place, unless otherwise noted.
 - 1. Cut off top 4 feet below grade, abandon remainder.
- B. Excavation support and protection systems not required to remain in place may be removed subject to approval of Government or Government's Representative.
 - 1. Remove temporary shoring and bracing in a manner to avoid harmful disturbance to underlying soils and damage to buildings, structures, pavements, facilities and utilities.

3.04 EXCAVATING

- A. Excavate to accommodate new structures and construction operations.
 - 1. Excavate to the specified elevations.
 - 2. Excavate to the length and width required to safely install, adjust, and remove any forms, bracing, or supports necessary for the installation of the work.
 - 3. Cut utility trenches wide enough to allow inspection of installed utilities.
 - 4. See Section 31 23 16.26 for required excavation clearances for pipes in utility trenches.
 - 5. Hand trim excavations. Remove loose matter.
- B. Notify Contracting Officer or Contracting Officer's Representative of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- C. Preparation for Piling Work: Excavate to working elevations. Coordinate special requirements for piling.
- D. Do not interfere with 45 degree bearing splay of foundations.
- E. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard measured by volume. See Section 31 23 16.26 for removal of larger material.
- F. Provide temporary means and methods, as required, to remove all water from excavations until directed by Contracting Officer or Contracting Officer's Representative. Remove and replace soils deemed suitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.05 SUBGRADE PREPARATION

- A. See Section 31 23 23 for subgrade preparation at general excavations.
- B. See Section 31 23 16.13 for subgrade preparation at utility trenches.

3.06 FILLING AND BACKFILLING

- A. Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from excavation.
- B. Install underground warning tape at buried utilities according to Sections 21 05 53, 22 05 53, 23 05 53, and 26 05 53.
- C. See Section 31 23 23 for fill, backfill, and compaction requirements at general excavations.
- D. See Section 31 23 16.13 for fill, backfill, and compaction requirements at utility trenches.
- E. See Section 31 22 00 for rough and final grading and topsoil replacement requirements.

3.07 REPAIR

- A. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 31 23 23.

3.08 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.
- B. Provide for visual inspection of load-bearing excavated surfaces by Contracting Officer or Contracting Officer's Representative before placement of foundations.

3.09 CLEANING

- A. Stockpile excavated material to be re-used in area designated on site in accordance with Section 31 22 00.
- B. Remove excavated material that is unsuitable for re-use from site.
- C. Remove excess excavated material from site.

3.10 PROTECTION

- A. Divert surface flow from rains or water discharges from the excavation.
- B. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.
- C. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in satisfactory, undisturbed condition.
- D. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.
- E. Keep excavations free of standing water and completely free of water during concrete placement.

END OF SECTION

**SECTION 31 23 16.13
TRENCHING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Trench excavation.
- B. Utility bedding and cover.
- C. Backfill and compaction.
- D. Dewatering.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 31 10 00 - Site Clearing.
- C. Section 31 22 00 - Grading.
- D. Section 31 23 16 - Excavation.
- E. Section 31 23 16.26 - Rock Removal.

1.03 PRICE AND PAYMENT PROCEDURES

- A. Unit Prices:
 - 1. See Section 01 22 00 - Unit Prices for additional requirements.
 - 2. Basis of Measurement for Trenching: By linear foot.

1.04 DEFINITIONS**1.05 REFERENCE STANDARDS**

- A. 29 CFR 1926 - Safety and Health Regulations for Construction.
- B. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
- C. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- D. ACI PRC-304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
- E. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
- F. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- G. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
- H. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- I. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
- J. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
- K. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
- L. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
- M. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- N. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

- O. ASTM D6103/D6103M - Standard Test Method for Flow Consistency of Controlled Low Strength Material (CLSM).
- P. ASTM D6432 - Standard Guide for Using the Surface Ground Penetration Radar Method for Subsurface Investigation.
- Q. ASTM D6817/D6817M - Standard Specification for Rigid Cellular Polystyrene Geofoam.
- R. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- S. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
- T. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
- U. NRMCA CLSM - Guide Specification for Controlled Low Strength Materials.

1.06 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate trenching with utility installation.

1.07 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Source Quality Control Submittals: Submit name of imported materials source.
 - 1. Results of gradation tests on proposed and actual materials used.
- C. Field Quality Control Submittals:
 - 1. Results of compaction density tests.
- D. Manufacturer's qualification statement.
- E. Installer's qualification statement.
- F. Testing agency's qualification statement.
- G. Compaction Density Test Reports.

1.08 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with minimum 3 years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of type specified, with minimum 3 years of documented experience.
- C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of type specified in this section.
- D. Documents at Project Site: Maintain at project site one copy of manufacturer's instructions, erection drawings, and shop drawings.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Deliver fill to project site in advance of need.
- C. When fill materials need on-site storage, locate stockpiles where indicated on drawings.
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. Granular Fill: Pit-run washed stone; free of shale, clay, friable materials, and debris.

1. Fill Type _____: Coarse aggregate, complying with State of Pennsylvania Highway Department standard.
2. Graded in accordance with ASTM D2487 Group Symbol GW.
3. Graded in accordance with ASTM C136/C136M, within the following limits:
 - a. 2-inch Sieve: 100 percent passing.
 - b. 1-inch Sieve: 95 percent passing.
 - c. 3/4-inch Sieve: 95 to 100 percent passing.
 - d. 5/8-inch Sieve: 75 to 100 percent passing.
 - e. 3/8-inch Sieve: 55 to 85 percent passing.
 - f. No.4 Sieve: 35 to 60 percent passing.
 - g. No.16 Sieve: 15 to 35 percent passing.
 - h. No.40 Sieve: 10 to 25 percent passing.
 - i. No.200 Sieve: 5 to 10 percent passing.
- B. Crushed Stone: Crusher-run, mineral aggregate, free of silt, clay, loam, friable or soluble materials, and organic matter.
 1. Type _____: Complying with State of Pennsylvania Highway Department standard.
 2. Grade in accordance with ASTM D2487 Group Symbol GM.
 3. Graded in accordance with ASTM C136/C136M, within the following limits:
 - a. Minimum Size: 1/4 inch.
 - b. Maximum Size: 5/8 inch.
- C. Filter Fabric: Geotextile, capable of material separation.
 1. Geotextile: Nonbiodegradable, woven.
 2. Geotextile: See Section 31 05 19.
- D. Sand: Natural river or bank, washed free of silt, clay, loam, friable or soluble materials, and organic matter.
 1. Type _____: Complying with State of Pennsylvania Highway Department standard.
 2. Grade in accordance with ASTM D2487 Group Symbol SW.
 3. Graded in accordance with ASTM C136/C136M; within the following limits:
 - a. No.4 Sieve: 100 percent passing.
 - b. No.14 Sieve: 10 to 100 percent passing.
 - c. No.50 Sieve: 5 to 90 percent passing.
 - d. No.100 Sieve: 4 to 30 percent passing.
 - e. No.200 Sieve: 0 percent passing.
 4. Sand Equivalent: In accordance with ASTM D2419.
- E. Concrete: Ready mix.
 1. Ready for placement in accordance with ASTM C94/C94M.
 2. Backfill: See Section 03 30 00; compressive strength of 2,500 psi.
- F. Flowable Fill: Controlled low-strength material in accordance with ASTM D6103/D6103M.
- G. General Fill - Fill Type ____: Subsoil excavated on-site.
- H. Structural Fill - Fill Type ____: Subsoil excavated on-site.
- I. Granular Fill - Gravel - Fill Type ____: Pit run washed stone; free of shale, clay, friable material and debris.
 1. Graded in accordance with ASTM C136/C136M, within the following limits:
- J. Granular Fill - Pea Gravel - Fill Type ____: Natural stone; washed, free of clay, shale, organic matter.
 1. Graded in accordance with ASTM C136/C136M, within the following limits:
- K. Sand - Fill Type ____: Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter.
 1. Graded in accordance with ASTM C136/C136M; within the following limits:

2.02 ACCESSORIES

- A. Underground Warning Tape: Suitable for direct burial.
 - 1. Bright-colored, continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mils, 0.004 inch thick.
- B. Buried Detection Wire: Copper, single strand, continuously insulated, 12 AWG, suitable for direct burial.

2.03 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Test fill materials in accordance with specified standard before delivery to site.
- C. Nonconforming Materials: Change and retest.
- D. Provide materials of each type from same source or as directed by Contracting Officer or Contracting Officer's Representative.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify survey benchmarks and intended elevations for work are as indicated on drawings.
- B. Verify prevailing groundwater level is as indicated on drawings.
- C. Perform assessment of adjacent structures and exterior improvements to establish existing conditions. Notify Contracting Officer or Contracting Officer's Representative of existing cracks, sags, or other damages prior to starting work.
- D. See Section 01 71 23 - Field Engineering for additional requirements.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. See Section 31 10 00 for site clearing and topsoil removal.
- C. Protect survey benchmarks, control points, and monuments from excavating equipment and vehicular traffic.
- D. Protect existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- E. Protect plants, lawns, rock outcroppings, and other features to remain.
- F. Locate and identify existing utilities to remain as indicated on drawings and protect from damage.
- G. Perform ground-penetrating radar surveys in accordance with ASTM D6432 for undocumented utilities to remain; protect from damage.
- H. Notify utility company to remove and relocate utilities as indicated on drawings.

3.03 SUPPORT AND PROTECTION

- A. Excavation Safety: Comply with OSHA's Excavation Standard, 29 CFR 1926, Subpart P.
- B. Abandon support and protection systems used as formwork or within 10 feet of existing foundations, unless otherwise noted on drawings.
 - 1. Remove top 4 feet below grade.
- C. Remove support and protection systems not required to remain in place, subject to approval of Contracting Officer or Contracting Officer's Representative.
 - 1. Prevent harmful disturbance to underlying soils and damage to buildings, structures, pavements, facilities, and utilities.

3.04 DEWATERING

- A. Prevent surface water and groundwater from entering excavations and surrounding areas.

- B. Dispose of water without causing surface erosion, sediment buildup, or endangering public health or property.

3.05 TRENCH EXCAVATION

- A. Grade top perimeter of excavation to prevent surface water collection.
- B. Notify Contracting Officer or Contracting Officer's Representative of unexpected subsurface conditions and discontinue affected work in area until notified to resume.
- C. General: Cut trenches neat and clean.
 - 1. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
 - 2. Do not interfere with 45-degree bearing splay of foundations.
 - 3. Cut trenches wide enough to allow inspection of installed utilities.
 - 4. Hand trim excavations and remove loose matter.
 - 5. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.
 - 6. Remove lumped subsoil, boulders, and rock up to 1/3 cu yd measured by volume.
 - 7. See Section 31 23 16.26 for rock removal.
- D. Utility Preparation: Rake trench bottom to uniform grade.
 - 1. Remove unsuitable subgrade and backfill.
 - 2. Compact subgrade to density equal to or greater than subsequent fill material requirements.
- E. Maintain trenches and prevent loose soil or rocks from entering.
- F. Notify Contracting Officer or Contracting Officer's Representative of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- G. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
- H. Do not interfere with 45 degree bearing splay of foundations.
- I. Cut trenches wide enough to allow inspection of installed utilities.
- J. Hand trim excavations. Remove loose matter.
- K. Remove excavated material that is unsuitable for re-use from site.
- L. Remove excess excavated material from site.
- M. Provide temporary means and methods, as required, to remove all water from trenching until directed by the Contracting Officer or Contracting Officer's Representative. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.
- N. Determine the prevailing groundwater level prior to trenching. If the proposed trench extends less than 1 foot into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by the Contracting Officer or Contracting Officer's Representative.

3.06 UTILITY BEDDING AND COVER

- A. Maintain trenches and prevent loose soil or rocks from entering.
- B. Crushed Stone: Compact to 95 percent of maximum dry density.
 - 1. Bedding: Fill to subgrade elevation; rake smooth.
- C. Sand: Compact in maximum 8-inch lifts to 95 percent of maximum dry density.
 - 1. Bedding: Fill to subgrade elevation; rake smooth.
- D. Filter Fabric: Position geosynthetic smooth and wrinkle-free on prepared surface; unroll or unfold carefully; avoid stretching.
 - 1. Wrap around crushed stone and utility assembly; overlap seams.
- E. Concrete: Place in accordance with ACI PRC-304.

3.07 FLOWABLE FILL

- A. Completely cover utilities in accordance with NRMCA CLSM.

3.08 PREPARATION FOR UTILITY PLACEMENT

- A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
- B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.09 BACKFILL AND COMPACTION

- A. Backfill to contours and elevations indicated on drawings using unfrozen materials.
- B. Fill to subgrade elevations unless otherwise indicated on drawings.
- C. Employ placement method that does not disturb or damage other work.
- D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen, or spongy subgrade surfaces.
- E. Maintain optimum moisture content of fill materials to attain required compaction density.
- F. General Fill: Place and compact materials in equal continuous layers not exceeding 8 inches compacted depth.
- G. Granular Fill: Place and compact material in equal continuous layers not exceeding 6 inches compacted depth.
- H. Slope grade away from building minimum 2 inches in 10 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- I. Correct areas that are over-excavated.
 - 1. Thrust-Bearing Surfaces: Fill with concrete.
 - 2. Other Areas: Backfill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- J. Compaction Density Unless Otherwise Specified or Indicated:
 - 1. Under paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density.
 - 2. At Other Locations: 95 percent of maximum dry density.
- K. Reshape and re-compact fills subjected to vehicular traffic.
- L. Underground Warning Tape:
 - 1. Install 6 to 8 inches below finished grade, directly above buried pipe.
- M. Buried Detection Wire: Install 6 to 8 inches below finished grade, directly above buried pipe.

3.10 TOLERANCES

- A. Maximum Variation from Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.
- B. Maximum Variation from Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch from required elevations.

3.11 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for general requirements for field inspection and testing.
- B. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.
- C. Nonconforming Work: For failed tests, remove work, replace, and retest.
- D. Frequency of Tests: Backfill mid-point and top.

3.12 CLEANING

- A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.

- B. Stockpile excavated material re-used in area designated on-site; see Section 31 22 00.
- C. Remove excavated material unsuitable for re-use from site.
- D. Remove excess excavated material from site.

3.13 PROTECTION

- A. Divert surface water away from excavations.
- B. Keep excavations free of standing water.
- C. Maintain stability of banks and loose soils; prevent from falling into excavations.
- D. Maintain excavations in neat and square, undisturbed condition.
- E. Protect bottom of excavations from freezing.

END OF SECTION

SECTION 31 23 23
FILL**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Filling, backfilling, and compacting for building volume below grade.
- B. Backfilling and compacting for utilities outside the building to utility main connections.
- C. Filling holes, pits, and excavations generated as a result of removal (demolition) operations.

1.02 RELATED REQUIREMENTS

- A. Section 01 57 13 - Temporary Erosion and Sediment Control: Slope protection and erosion control.
- B. Section 31 22 00 - Grading: Site grading.
- C. Section 31 23 16 - Excavation: Removal and handling of soil to be re-used.
- D. Section 31 23 16.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 01 22 00 - Unit Prices, for general requirements applicable to unit prices for earthwork.

1.04 DEFINITIONS

- A. Finish Grade Elevations: Indicated on drawings.

1.05 REFERENCE STANDARDS

- A. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
- B. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- C. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- D. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- E. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
- F. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
- G. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
- H. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- I. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.06 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used, including manufactured fill.
- C. Compaction Density Test Reports.
- D. Testing Agency Qualification Statement.

1.07 QUALITY ASSURANCE

- A. Designer Qualifications: Perform design of structural fill under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the Commonwealth of Pennsylvania.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than ten years of documented experience.
- C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.
- D. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. When fill materials need to be stored on site, locate stockpiles where indicated.
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion and deterioration of materials.

1.09 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS**2.01 FILL MATERIALS**

- A. General Fill - Fill Type Common Fill: Complying with State of Pennsylvania Highway Department standard.
- B. Structural Fill - Fill Type 2A aggregate: Complying with State of Pennsylvania Highway Department standard.
- C. Topsoil: See Section 31 22 00.

2.02 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.
- B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.
- C. If tests indicate materials do not meet specified requirements, change material and retest.
- D. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that survey bench marks and intended elevations for the Work are as indicated.
- B. Identify required lines, levels, contours, and datum locations.
- C. Verify areas to be filled are not compromised with surface or ground water.

3.02 PREPARATION

- A. Scarify and proof roll subgrade surface to a depth of 6 inches to identify soft spots.
- B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
- C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.03 FILLING

- A. Fill to contours and elevations indicated using unfrozen materials.
- B. Fill up to subgrade elevations unless otherwise indicated.
- C. Employ a placement method that does not disturb or damage other work.
- D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- E. Maintain optimum moisture content of fill materials to attain required compaction density.
- F. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.
- G. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.
- H. Slope grade away from building minimum 2 inches in 10 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- I. Correct areas that are over-excavated.
 - 1. Load-bearing foundation surfaces: Use structural fill, flush to required elevation, compacted to 100 percent of maximum dry density.
 - 2. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- J. Compaction Density Unless Otherwise Specified or Indicated:
 - 1. Under paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density.
 - 2. At other locations: 95 percent of maximum dry density.
- K. Reshape and re-compact fills subjected to vehicular traffic.
- L. Maintain temporary means and methods, as required, to remove all water while fill is being placed as required, or until directed by the Contracting Officer or Contracting Officer's Representative. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.04 FILL AT SPECIFIC LOCATIONS

- A. Use general fill unless otherwise specified or indicated.
- B. Structural Fill at all paved area, walls, foundations, utility pipes, utility structures and under buildings.:
 - 1. Maximum depth per lift: 6 inches, compacted.
 - 2. Compact to minimum 95 percent of maximum dry density.
- C. At Lawn Areas:
 - 1. Use general fill.
 - 2. Fill up to 6 inches below finish grade elevations.
 - 3. Fill up to subgrade elevations.
 - 4. Compact to 95 percent of maximum dry density.
 - 5. See Section 31 22 00 for topsoil placement.

3.05 TOLERANCES

- A. Top Surface of General Filling: Plus or minus 1 inch from required elevations.

3.06 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.
- B. Soil Fill Materials:
 - 1. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.

2. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D698 ("standard Proctor"), ASTM D1557 ("modified Proctor"), or AASHTO T 180.
3. If tests indicate work does not meet specified requirements, remove work, replace and retest.
4. Frequency of Tests: _____.
5. Proof roll compacted fill at surfaces that will be under slabs-on-grade.

3.07 CLEANING

- A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.
- B. Leave unused materials in a neat, compact stockpile.
- C. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
- D. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

**SECTION 31 25 00
EROSION AND SEDIMENTATION CONTROLS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Permanent erosion and sediment control.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete for permanent erosion control structures indicated on drawings.
- B. Section 31 23 23 - Fill: Filling and compaction.
- C. Section 32 01 90 - Operation and Maintenance of Planting: Post-occupancy maintenance.
- D. Section 32 11 23 - Aggregate Base Courses: Aggregate base course.
- E. Section 32 92 19 - Seeding: Permanent turf for erosion control.

1.03 PRICE AND PAYMENT PROCEDURES

- A. Topsoil:
 - 1. Basis of Measurement: By the cubic yard.
 - 2. Basis of Payment: Includes topsoil, placing topsoil.
- B. Grassed Areas:
 - 1. Basis of Measurement: By the square yard.

1.04 REFERENCE STANDARDS

- A. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
- B. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- C. ASTM D5338 - Standard Test Method for Determining Aerobic Biodegradation of Plastic Materials Under Controlled Composting Conditions, Incorporating Thermophilic Temperatures.
- D. ASTM D7367 - Standard Test Method for Determining Water Holding Capacity of Fiber Mulches for Hydraulic Planting.
- E. EPA (NPDES) - National Pollutant Discharge Elimination System (NPDES), Construction General Permit.
- F. FHWA FLP-94-005 - Best Management Practices for Erosion and Sediment Control.
- G. USDA TR-55 - Urban Hydrology for Small Watersheds; USDA Natural Resources Conservation Service.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Inspection Reports: Submit report of each inspection; identify each preventive measure, indicate condition, and specify maintenance or repair required and accomplished.
- C. Maintenance Instructions: Provide instructions covering inspection and maintenance for preventive measures that must remain after Substantial Completion.

PART 2 PRODUCTS**2.01 PERFORMANCE REQUIREMENTS**

- A. Comply with requirements of EPA (NPDES) for erosion and sedimentation control, as specified by the NPDES, for Phases I and II, and in compliance with requirements of Construction General Permit (CGP), whether the project is required by law to comply or not.
- B. Comply with more stringent requirements of State of Pennsylvania Erosion and Sedimentation Control Manual.

2.02 ACCESSORY MATERIALS

- A. Fill Material: See Section 31 23 23.
- B. Fill Material: Soil, concrete, granular fill, sand, crushed stone, or waste materials used to raise an existing grade, acceptable to authorities having jurisdiction, and in compliance with specified performance requirements.
- C. Geotextiles: Permeable, synthetic fabric used to stabilize loose soil and prevent erosion.
- D. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.
- E. Grass Seed for Permanent Cover: See Section 32 92 19.
- F. Crushed Stone and Gravel: See Section 32 11 23 for aggregate.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.02 PREPARATION

- A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.
- B. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish documentation required to obtain applicable permits.
- C. Timing: Put preventive measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.

3.03 FIELD QUALITY CONTROL

- A. Provide analysis of topsoil fill; see Section 01 40 00.
- B. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.
- C. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

3.04 INSTALLATION

- A. Hydroseeding: Apply seeded slurry with a hydraulic seeder at a rate of ____ lbs per acre evenly in two intersecting directions.
 - 1. Soil Amendment: Provide soil amendments for application with hydroseeding slurry at manufacturer's recommended rates based on soil test results.
- B. Do not seed areas in excess of that which can be mulched on same day.
- C. Immediately following seeding, apply mulch to a thickness of 1/8 inch. Maintain clear of shrubs and trees.
- D. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.
- E. Following germination, immediately reseed areas without germinated seeds that are larger than 4 by 4 inches.

3.05 PROTECTION

- A. Cover seeded slopes where grade is 4 inches per foot or greater with geotextile fabric. Roll fabric onto slopes without stretching or pulling.
- B. Lay fabric smoothly on surface, bury top end of each section in 6-inch deep excavated topsoil trench. Provide 12-inch overlap of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil.

- C. Secure outside edges and overlaps at 36-inch intervals with stakes.
- D. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.
- E. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches.

3.06 MAINTENANCE

- A. See Section 32 01 90 for post-occupancy maintenance.
- B. Provide maintenance of seeded areas for three months from Date of Substantial Completion.
- C. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
- D. Immediately reseed areas that show bare spots.
- E. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5 inches or more rainfall at the project site, and daily during prolonged rainfall.
- F. Repair deficiencies immediately.

3.07 CLEAN UP

- A. Clean out sediment control structures that are to remain as permanent measures.

END OF SECTION

**SECTION 31 62 16.16
STEEL H PILES****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Rolled steel section piles.
- B. Pile load testing.

1.02 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- B. ASTM A690/A690M - Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments.
- C. ASTM D1143/D1143M - Standard Test Methods for Deep Foundation Elements Under Static Axial Compressive Load.
- D. ASTM D3689/D3689M - Standard Test Methods for Deep Foundation Elements Under Static Axial Tensile Load.
- E. ASTM D3966/D3966M - Standard Test Methods for Deep Foundation Elements Under Static Lateral Load.
- F. ASTM D4945 - Standard Test Method for High-Strain Dynamic Testing of Deep Foundations.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide details of collars.
- C. Shop Drawings: Indicate details and schedule of pile installation sequence.
- D. Welders Certificates.
- E. Manufacturer's Mill Certificate: Certify that steel casings meets or exceeds specified requirements.
- F. Certificate of compliance from authority having jurisdiction indicating approval.
- G. Designer's qualification statement.
- H. Installer's qualification statement.
- I. Project Record Documents: Accurately record the following:
 - 1. Sizes, lengths, and locations of piles.
 - 2. Sequence of driving.
 - 3. Number of blows per foot for entire length of piles and measured set for last 10 blows.
 - 4. Identify piles requiring drilling, and hole diameters.
 - 5. Final base and top elevations.
 - 6. Driving force of each hammer blow.
- J. Pile Load Test Report, including:
 - 1. Location identification.
 - 2. Description of testing equipment.
 - 3. Calibration method and recordings.
 - 4. Installation records.
 - 5. Recorded data.
 - 6. Modulus test.
 - 7. Bottom stabilization test.

8. Cap stabilization test.
9. Uplift load test.
10. Data analysis.
11. Recommendation of design loads.
12. Description of subsurface conditions.
13. Pier installation recommendations.

1.05 QUALITY ASSURANCE

- A. Designer Qualifications: Perform design under direct supervision of Professional Engineer experienced in design of this type of work and licensed in the Commonwealth of Pennsylvania.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
- C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of type specified in this section.
- D. Monitor test pile placement and elevations under direct supervision of Professional Engineer experienced in design of this work and licensed in the Commonwealth of Pennsylvania.
- E. Certify welders employed on work, verifying AWS qualification within previous 12 months.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Piles: In accordance with ASTM A690/A690M; structural steel, rolled H sections, minimum 50 ksi yield strength; sizes and lengths indicated on drawings.
- B. Accessories: Points, driving cap; to suit pile shape.

2.02 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.

2.03 FABRICATION

- A. Coat pile with specified protective cover in accordance with manufacturer's instructions.
- B. Allow to cure before driving piles.

PART 3 EXECUTION

3.01 PREPARATION

- A. Obtain prior approval of hammer type to be used.
- B. Use driving method that will not cause damage to nearby structures.
- C. Notify Government and adjacent and affected land owners and building occupants with 90 days notice before proceeding with work.
- D. Prepare to place piles from existing site elevations.

3.02 INSTALLATION

- A. Drive piles to defined load supporting capacity.
- B. Protect pile head during driving. Use cushion cap with full bearing on pile butt for even distribution of hammer blow.
- C. Deliver hammer blows to central axis of pile.
- D. If driving is interrupted before refusal, drive an additional 12 inches before resuming recording of performance data.
- E. Re-drive piles that have lifted due to driving adjacent piles, or by soil uplift.
- F. Do not damage piles during driving operations.

- G. Cut off tops of piles to elevations indicated and prepare pile top to receive pile caps.

3.03 QUALITY ASSURANCE

- A. Pile driving logs are to be prepared for all piles.
- B. Six piles are to be tested, the piles can be production piles. Contact the Contracting Officer to assist with location of the piles. Tested piles: two (2) in the Simulator area, two (2) in the Simulator foundation area and two (2) in the Administration foundation area.
- C. Pile Testing is to follow four (4) piles tested using ASTM D1143 Standard Test Method for Piles Under Static Axial Compressive Load The Piles are to be testing with Static Load Test. And the two (2) piles under the Simulator for Dynamic Load Test using a Pile Dynamic Analyzer (PDA)

END OF SECTION

SECTION 32 11 20
SUBBASE AND AGGREGATE BASE COURSES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Subbase course.
- B. Geosynthetic reinforcement.
- C. Aggregate base course.

1.02 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading.
- B. Section 31 23 16.13 - Trenching.
- C. Section 31 23 23 - Fill.
- D. Section 32 13 13 - Concrete Paving.
- E. Section 32 16 23 - Sidewalks.

1.03 PRICE AND PAYMENT PROCEDURES**1.04 REFERENCE STANDARDS**

- A. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
- B. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- C. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- D. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- E. ASTM D1241 - Standard Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses.
- F. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
- G. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
- H. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
- I. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- J. ASTM D3665 - Standard Practice for Random Sampling of Construction Materials.
- K. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- L. ASTM D5397 - Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.
- M. ASTM D6693/D6693M - Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.
- N. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

- B. Product Data: Geogrid indicating tensile strength.
- C. Test Reports:
 - 1. Aggregate Composition: Results of laboratory tests on proposed and actual materials used.
 - 2. Compaction Density: Results of laboratory tests on compacted course.
- D. Manufacturer's Instructions: Indicate geosynthetic installation procedure.
- E. Source Quality Control Submittals: Submit name of imported materials source.
- F. Field Quality Control Submittals: Submit compaction density testing results.
- G. Testing agency's qualification statement.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified and with minimum three years of documented experience.
- B. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of type specified in this section.
- C. Documents at Project Site: Maintain at project site one copy of manufacturer's instructions.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Deliver geosynthetic to project site wrapped in protective covering, maintain prior to use.
- C. Aggregate Storage: Prevent material intermixing, contamination, and deterioration.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Subbase Course:
 - 1. Type 2A : Comply with State of Pennsylvania Highway Department standard.
 - 2. Graded in accordance with ASTM D2487 Group Symbol SW.
 - 3. Graded in accordance with ASTM C136/C136M, within the following limits:
 - a. 1 inch sieve: 100 percent passing.
 - b. 3/8 inch sieve: 60 to 100 percent passing.
 - c. No.4 sieve: 50 to 85 percent passing.
 - d. No.10 sieve: 40 to 70 percent passing.
 - e. No.40: 25 to 45 percent passing.
 - f. No.200: 8 to 15 percent passing.
 - 4. Type: Type I, in accordance with ASTM D1241.
 - a. Gradation: Gradation C.
 - b. Gradation: Gradation E.
- B. Geosynthetic:
 - 1. Geotextile: Nonbiodegradable, woven.
 - 2. Geocell Grid: High density polyethylene, perforated.
 - a. Cell Depth: 3 inches (76 mm).
 - b. Cell Area: 45 sq in (290 sq cm), nominal.
- C. Aggregate Base Course:
 - 1. Type 2A : Comply with State of Pennsylvania Highway Department standard.
 - 2. Graded according to ASTM D2487 Group Symbol GW.
 - 3. Graded in accordance with ASTM C136/C136M, within the following limits:
 - a. 2 inch sieve: 100 percent passing.
 - b. 1 inch sieve: 75 to 95 percent passing.
 - c. 3/8 inch sieve: 40 to 75 percent passing.
 - d. No.4 sieve: 30 to 60 percent passing.

- e. No.10 sieve: 20 to 45 percent passing.
- f. No.40: 15 to 30 percent passing.
- g. No.200: 5 to 15 percent passing.
- 4. Type: Type I, in accordance with ASTM D1241.
 - a. Gradation: Gradation A.

2.02 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. If tests indicate materials do not meet specified requirements, change material and retest.
- C. Provide materials of each type from same source throughout the Work.
- D. For aggregate materials using classification complying with ASTM D2487, provide testing before delivery to site.

PART 3 EXECUTION

3.01 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and recompacting.
- B. Do not place aggregate on soft, muddy, or frozen surfaces.
- C. Grade excavated and filled substrate; see Section 31 22 00.
- D. Backfill and compact trench excavations; see Section 31 23 16.13.
- E. Backfill and compact subgrade fill; see Section 31 23 23.

3.02 PLACEMENT

- A. Under Bituminous Concrete Paving:
 - 1. Subbase Compacted Thickness: According to design drawings.
 - 2. Install geosynthetic reinforcement on substrate in accordance with manufacturers instructions.
 - 3. Aggregate Base Compacted Thickness: According to design drawings.
 - 4. Compact to 95 percent of maximum dry density.
- B. Under Portland Cement Concrete Paving:
 - 1. Subbase Compacted Thickness: According to design drawings.
 - 2. Install geosynthetic reinforcement on substrate in accordance with manufacturers instructions.
 - 3. Aggregate Base Compacted Thickness: According to design drawings.
 - 4. Compact to 95 percent of maximum dry density.
- C. Spread course uniformly over prepared substrate to a total compacted thickness:
 - 1. Subbase Thickness: According to design drawings.
 - 2. Install geosynthetic reinforcement on substrate in accordance with manufacturers instructions.
 - 3. Aggregate Base Thickness: According to design drawings.
 - 4. Compact to 95 percent of maximum dry density.
- D. Place course in maximum 4 inch layers and roller compact to specified density.
- E. Level and contour surfaces to elevations and gradients indicated.
- F. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.03 TOLERANCES

- A. Variation From Design Elevation: Within 1/2 inch.
- B. Flatness: Maximum variation of 1/2 inch measured with 10 foot straight edge.
- C. Scheduled Compacted Thickness: Within 1/2 inch.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Subbase Compaction Density Testing: In accordance with ASTM D1556/D1556M, ASTM D2167, or ASTM D6938.
- C. Aggregate Base Compaction Density Testing: In accordance with ASTM D1556/D1556M, ASTM D2167, or ASTM D6938.
- D. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with AASHTO T 180, ASTM D698 ("standard Proctor"), or ASTM D1557 ("modified Proctor").
- E. Frequency of Tests: In accordance with ASTM D3665.
- F. Remove, replace, and retest work that does not meet specified requirements.
- G. Proof roll compacted aggregate at surfaces going underneath flexible paving.

3.05 CLEANING

- A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.
- B. Stockpile unused materials neat and compact.
- C. Remove unused materials and grade areas to prevent standing surface water.

END OF SECTION

**SECTION 32 12 16
ASPHALT PAVING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Aggregate base course.
- B. Single course bituminous concrete paving.
- C. Double course bituminous concrete paving.
- D. Surface sealer.

1.02 RELATED REQUIREMENTS

- A. Section 09 91 13 - Exterior Painting: Pavement markings.
- B. Section 31 22 00 - Grading: Preparation of site for paving and base.
- C. Section 32 11 20 - Subbase and Aggregate Base Courses.
- D. Section 32 13 13 - Concrete Paving: Concrete substrate.
- E. Section 32 13 13 - Concrete Paving: Concrete curbs.
- F. Section 32 17 23 - Pavement Markings.
- G. Section 33 05 61 - Concrete Manholes: Manholes, including frames; gutter drainage grilles, covers, and frames for placement by this section.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 01 22 00 - Unit Prices for requirements applicable to this section. Measurement and payment will be as follows:
- B. Asphalt Pavement Mix (Base Course): By the ton. Includes preparing base, tack coating surfaces, placing, compacting and rolling, testing. Includes mix design, supplying to site, testing.
- C. Asphalt Pavement Mix (Binder Course): By the ton. Includes preparing base, tack coating surfaces, placing, compacting and rolling, testing. Includes mix design, supplying to site, testing.
- D. Asphalt Pavement Mix (Wearing Course): By the ton. Includes preparing base, tack coating surfaces, placing, compacting and rolling, testing. Includes mix design, supplying to site, testing.
- E. Seal Coat: By the square yard. Includes preparing surfaces and applying.

1.04 REFERENCE STANDARDS

- A. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
- B. AI MS-2 - Asphalt Mix Design Methods.
- C. AI MS-19 - Basic Asphalt Emulsion Manual.
- D. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- E. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction.
- F. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- G. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Pennsylvania Highways standard.
- B. Mixing Plant: Complying with State of Pennsylvania Highways standard.
- C. Obtain materials from same source throughout.

1.06 FIELD CONDITIONS

- A. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F, or surface is wet or frozen.
- B. Place bitumen mixture when temperature is not more than 15 F degrees below bitumen supplier's bill of lading and not more than maximum specified temperature.

PART 2 PRODUCTS**2.01 REGULATORY REQUIREMENTS**

- A. Comply with applicable code for paving work on public property.

2.02 MATERIALS

- A. Asphalt Cement: ASTM D946.
- B. Aggregate for Base Course: In accordance with State of Pennsylvania Highways standards.
- C. Aggregate for Binder Course: In accordance with State of Pennsylvania Highways standards.
- D. Aggregate for Wearing Course: In accordance with State of Pennsylvania Highways standards.
- E. Fine Aggregate: In accordance with State of Pennsylvania Highways standards.
- F. Mineral Filler: Finely ground particles of limestone, hydrated lime or other mineral dust, free of foreign matter.
- G. Primer: In accordance with State of Pennsylvania Highways standards.
- H. Tack Coat: Homogeneous, medium curing, liquid asphalt.
- I. Seal Coat: AI MS-19, sand type.

2.03 ASPHALT PAVING MIXES AND MIX DESIGN

- A. Use dry material to avoid foaming. Mix uniformly.
- B. Asphalt Base Course: 3.0 to 6 percent of asphalt cement by weight in mixture in accordance with AI MS-2.
- C. Asphalt Binder Course: 4.5 to 6 percent of asphalt cement by weight in mixture in accordance with AI MS-2.
- D. Asphalt Wearing Course: 5 to 7 percent of asphalt cement by weight in mixture in accordance with AI MS-2.
- E. Submit proposed mix design of each class of mix for review prior to beginning of work.

2.04 SOURCE QUALITY CONTROL

- A. Test mix design and samples in accordance with AI MS-2.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that compacted subgrade is dry and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

3.02 AGGREGATE BASE COURSE

- A. Place and compact aggregate base course.

3.03 PREPARATION - PRIMER

- A. Apply primer in accordance with manufacturer's instructions.

- B. Apply primer on aggregate base or subbase at uniform rate of 1/3 gal/sq yd.
- C. Apply primer to contact surfaces of curbs, gutters.
- D. Use clean sand to blot excess primer.

3.04 PREPARATION - TACK COAT

- A. Apply tack coat in accordance with manufacturer's instructions.
- B. Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of 1/3 gal/sq yd.
- C. Apply tack coat to contact surfaces of curbs, gutters and structures.
- D. Coat surfaces of manhole frames with oil to prevent bond with asphalt pavement. Do not tack coat these surfaces.

3.05 PLACING ASPHALT PAVEMENT - SINGLE COURSE

- A. Install Work in accordance with State of Pennsylvania Highways standards.
- B. Place asphalt within 24 hours of applying primer or tack coat.
- C. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- D. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.06 PLACING ASPHALT PAVEMENT - DOUBLE COURSE

- A. Place asphalt binder course within 24 hours of applying primer or tack coat.
- B. Place asphalt wearing course within two hours of placing and compacting binder course.
- C. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- D. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.07 SEAL COAT

- A. Apply seal coat to asphalt surface course and asphalt curbs in accordance with AI MS-19.

3.08 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.
- B. Compacted Thickness: Within 1/4 inch of specified or indicated thickness.
- C. Variation from True Elevation: Within 1/2 inch.

3.09 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for quality control.
- B. Provide field inspection and testing. Take samples and perform tests in accordance with AI MS-2.

3.10 PROTECTION

- A. Immediately after placement, protect pavement from mechanical injury for ____ days or until surface temperature is less than 140 degrees F.

3.11 SCHEDULE

- A. Pavement at Truck Ramp and Garbage Area: Single course of 3-1/2 inch compacted thickness, sand seal coat.
- B. Pavement at Parking Areas: Two courses; binder course of 2-1/2 inch compacted thickness and wearing course of 1 inch compacted thickness, fog seal coat.
- C. Pavement at Rear Bus Loading Area: Thickness and compaction of subbase to support vehicles up to 30,000 lb.

- D. Pavement Front Sidewalks: Thickness and compaction of subbase to support moderate pedestrian traffic.

END OF SECTION

**SECTION 32 13 13
CONCRETE PAVING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Concrete sidewalks, stair steps, integral curbs, gutters, median barriers, parking areas, and roads.

1.02 RELATED REQUIREMENTS

- A. Section 03 10 00 - Concrete Forming and Accessories.
- B. Section 03 20 00 - Concrete Reinforcing.
- C. Section 03 30 00 - Cast-in-Place Concrete.
- D. Section 07 92 00 - Joint Sealants: Sealing joints.
- E. Section 31 22 00 - Grading: Preparation of site for paving and base and preparation of subsoil at pavement perimeter for planting.
- F. Section 32 17 26 - Tactile Warning Surfacing: Plastic tactile and detectable warning tiles for pedestrian walking surfaces.

1.03 PRICE AND PAYMENT PROCEDURES

- A. Provide concrete paving by the unit price method.
- B. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
- C. Concrete Pavement Mix (Base): Measurement by the cubic yard. Includes mix design, supplying to site, testing.
- D. Concrete Pavement Mix (Wearing Course): Measurement by the cubic yard. Includes mix design, supplying to site, testing.

1.04 REFERENCE STANDARDS

- A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
- B. ACI 301 - Specifications for Concrete Construction.
- C. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
- D. ACI 305R - Guide to Hot Weather Concreting.
- E. ACI 306R - Guide to Cold Weather Concreting.
- F. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
- G. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- H. ASTM C33/C33M - Standard Specification for Concrete Aggregates.
- I. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- J. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
- K. ASTM C150/C150M - Standard Specification for Portland Cement.
- L. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
- M. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete.
- N. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- O. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.

- P. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
- Q. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing.
- R. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- S. ASTM D1752 - Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
- T. ASTM D8139 - Standard Specification for Semi-Rigid, Closed-Cell Polypropylene Foam, Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on joint filler, admixtures, and curing compound.
- C. Design Data: Indicate pavement thickness, designed concrete strength, reinforcement, and typical details.

PART 2 PRODUCTS

2.01 FORM MATERIALS

- A. Form Materials: As specified in Section 03 10 00, comply with ACI 301.
- B. Wood form material, profiled to suit conditions.
- C. Joint Filler: Preformed; non-extruding bituminous type (ASTM D1751) or sponge rubber or cork (ASTM D1752).
 - 1. Thickness: 1/2 inch.

2.02 REINFORCEMENT

- A. Reinforcing Steel and Welded Wire Reinforcement: Types specified in Section 03 20 00.
- B. Reinforcing Steel: ASTM A615/A615M, Grade 80 (80,000 psi) yield strength; deformed billet steel bars; unfinished.
- C. Steel Welded Wire Reinforcement: Plain type, ASTM A1064/A1064M; in flat sheets; unfinished.
- D. Dowels: ASTM A615/A615M, Grade 40 - 40,000 psi yield strength; deformed billet steel bars; unfinished finish.

2.03 CONCRETE MATERIALS

- A. Obtain cementitious materials from same source throughout.
- B. Concrete Materials: As specified in Section 03 30 00.
- C. Cement: ASTM C150/C150M, Normal - Type I Portland cement, gray color.
- D. Fine and Coarse Mix Aggregates: ASTM C33/C33M.
- E. Fly Ash: ASTM C618, Class C or F.
- F. Calcined Pozzolan: ASTM C618, Class N.
- G. Silica Fume: ACI 211.1.
- H. Water: Clean, and not detrimental to concrete.
- I. Fiber Reinforcement: Synthetic fibers shown to have long-term resistance to deterioration when in contact with alkalis and moisture; 1/2 inch length.
- J. Air-Entraining Admixtures: ASTM C260/C260M.
- K. Chemical Admixtures: ASTM C494/C494M, Type A - Water Reducing, Type C - Accelerating, and Type G - Water Reducing, High Range and Retarding.

1. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.

2.04 ACCESSORIES

- A. Curing Compound: ASTM C309, Type 1, Class A.
- B. Liquid Surface Sealer: _____.
- C. Surface Retarder:
 1. Color: As selected by Contracting Officer or Contracting Officer's Representative from manufacturer's standard range.
 2. Color: As indicated.
- D. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.
 1. Material: ASTM D1751, cellulose fiber.
 2. Material: ASTM D1752 sponge rubber (Type I).
 3. Material: ASTM D8139, semi-rigid, closed-cell polypropylene foam.
 4. Material: Closed-cell, non-absorbent, compressible polymer foam in sheet form.
 5. Manufacturers:
 - a. Nomaco, Inc; Nomaflex Expansion Joint Filler with Void Cap Option:
www.nomaco.com/#sle.
 - b. Nomaco, Inc; Fastflex Slab Isolation Joint Filler with Tear-Off Strip:
www.nomaco.com/#sle.
- E. Tactile Warning Surfaces: See Section 32 17 26.

2.05 CONCRETE MIX DESIGN

- A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
- B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
 1. For trial mixtures method, employ independent testing agency acceptable to Contracting Officer or Contracting Officer's Representative for preparing and reporting proposed mix designs.
- C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.
- D. Fiber Reinforcement: Add to mix at rate of 1.5 pounds per cubic yard, or as recommended by manufacturer for specific project conditions.
- E. Concrete Properties:
 1. Compressive strength, when tested in accordance with ASTM C39/C39M at 28 days; 4000 psi.
 2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.
 3. Calcined Pozzolan Content: Maximum 10 percent of cementitious materials by weight.
 4. Silica Fume Content: Maximum 5 percent of cementitious materials by weight.
 5. Cement Content: Minimum ____ lb per cubic yard.
 6. Water-Cement Ratio: Maximum 40 percent by weight.
 7. Total Air Content: 4 percent, determined in accordance with ASTM C173/C173M.
 8. Maximum Slump: 3 inches.
 9. Maximum Aggregate Size: ____ inch.

2.06 MIXING

- A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685/C685M. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.
- B. Transit Mixers: Comply with ASTM C94/C94M.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

3.02 SUBBASE

- A. See Section 32 11 23 for construction of base course for work of this Section.
- B. Prepare subbase in accordance with State of Pennsylvania Highways standards.

3.03 PREPARATION

- A. Moisten base to minimize absorption of water from fresh concrete.
- B. Coat surfaces of manhole frames with oil to prevent bond with concrete pavement.
- C. Notify Contracting Officer or Contracting Officer's Representative minimum 24 hours prior to commencement of concreting operations.

3.04 FORMING

- A. Place and secure forms to correct location, dimension, profile, and gradient.
- B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
- C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.05 REINFORCEMENT

- A. Place reinforcement at top of slabs-on-grade.
- B. Place reinforcement as indicated.
- C. Interrupt reinforcement at contraction joints.
- D. Place dowels to achieve pavement and curb alignment as detailed.

3.06 COLD AND HOT WEATHER CONCRETING

- A. Follow recommendations of ACI 305R when concreting during hot weather.
- B. Follow recommendations of ACI 306R when concreting during cold weather.
- C. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

3.07 PLACING CONCRETE

- A. Coordinate installation of snow melting components.
- B. Place concrete in accordance with ACI 304R.
- C. Place concrete in accordance with State of Pennsylvania Highways standards.
- D. Do not place concrete when base surface is wet.
- E. Place concrete using the slip form technique.
- F. Ensure reinforcement, inserts, embedded parts, formed joints and ____ are not disturbed during concrete placement.
- G. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.
- H. Apply surface retarder to all exposed surfaces in accordance with manufacturer's instructions.

3.08 JOINTS

- A. Align curb, gutter, and sidewalk joints.
- B. Place 3/8 inch wide expansion joints at 20 foot intervals and to separate paving from vertical surfaces and other components and in pattern indicated.

1. Form joints with joint filler extending from bottom of pavement to within 1/2 inch of finished surface.
2. Secure to resist movement by wet concrete.
- C. Provide scored joints.
 1. At 3 feet intervals.
 2. Between sidewalks and curbs.
 3. Between curbs and pavement.
- D. Provide keyed joints as indicated.
- E. Saw cut contraction joints 3/16 inch wide at an optimum time after finishing. Cut 1/3 into depth of slab.

3.09 FINISHING

- A. Area Paving: Light broom, texture perpendicular to pavement direction.
- B. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius.
- C. Curbs and Gutters: Light broom, texture parallel to pavement direction.
- D. Inclined Vehicular Ramps: Broomed perpendicular to slope.
- E. Place sealer on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.10 TOLERANCES

- A. Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.
- B. Maximum Variation From True Position: 1/4 inch.

3.11 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.
 1. Provide free access to concrete operations at project site and cooperate with appointed firm.
 2. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
 3. Tests of concrete and concrete materials may be performed at any time to ensure compliance with specified requirements.
- B. Compressive Strength Tests: ASTM C39/C39M; for each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd or less of each class of concrete placed.
 1. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
 2. Perform one slump test for each set of test cylinders taken.
- C. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.12 PROTECTION

- A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.
- B. Do not permit pedestrian traffic over pavement for 7 days minimum after finishing.
- C. Do not permit pedestrian traffic over pavement until 75 percent design strength of concrete has been achieved.

END OF SECTION

**SECTION 32 16 23
SIDEWALKS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Concrete sidewalks.
- B. Concrete wheelchair ramps.

1.02 RELATED REQUIREMENTS

- A. Section 32 11 20 - Subbase and Aggregate Base Courses.
- B. Section 32 13 13 - Concrete Paving.
- C. Section 32 17 26 - Tactile Warning Surfacing.

1.03 PRICE AND PAYMENT PROCEDURES

- A. Provide concrete sidewalk paving by the unit price method.
- B. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
- C. Concrete for Sidewalks: Measurement by the square yard. Includes mix design, supplying to site, preparing base, placing, floating, finishing and verification.

1.04 REFERENCE STANDARDS

- A. ACI PRC-211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide.
- B. ACI PRC-305 - Guide to Hot Weather Concreting.
- C. ACI PRC-306 - Guide to Cold Weather Concreting.
- D. ADA Standards - 2010 ADA Standards for Accessible Design.
- E. ANSI A137.1 - American National Standard Specifications for Ceramic Tile.
- F. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- G. ASTM C33/C33M - Standard Specification for Concrete Aggregates.
- H. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
- I. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
- J. ASTM C157/C157M - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
- K. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- L. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
- M. ASTM C1116/C1116M - Standard Specification for Fiber-Reinforced Concrete.
- N. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- O. ASTM D1752 - Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
- P. COE CRD-C 48 - Handbook for Concrete and Cement Standard Test Method for Water Permeability of Concrete.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Concrete: Provide data on admixtures.

- C. Samples: Submit two sample paver units indicating color, surface finish, and texture.
- D. Weather Data: Records during placement of asphalt or concrete, including date, location of placement, quantity, and air temperature.

1.06 FIELD CONDITIONS

- A. Follow recommendations of polymeric sand manufacturer.

PART 2 PRODUCTS

2.01 CONCRETE SIDEWALKS AND WHEELCHAIR RAMPS

- A. Gravel Subbase: Thickness as indicated on drawings.
- B. Concrete Forms: Wood.
- C. Concrete Materials: Comply with ASTM C94/C94M.
- D. Aggregate: Pit Run, washed, 3/8 inch (1 cm) stone; free of shale, clay, friable material and debris.
- E. Reinforcement:
 - 1. Steel Welded Wire Reinforcement: ASTM A1064/A1064M, plain type, flat sheets, unfinished.
 - 2. Fiber Reinforcement: 1 percent, steel fibers, according to ASTM C1116/C1116M.
- F. Waterproofing Admixture: Admixture formulated to reduce permeability to liquid water, with no adverse effect on concrete properties.
 - 1. Permeability of Cured Concrete: No measurable leakage when tested in accordance with COE CRD-C 48 at 200 psi; provide test reports.
- G. Joint Filler: Preformed expansion, with a thickness of 1/2 inch.
- H. Curing Compound: Synthetic, Type 1, Class A, according to ASTM C309.
- I. Surface Sealer: Topical, Type 1, Class A, according to ASTM C1315.
- J. Tactile Warning Surfaces: See Section 32 17 26.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify gradients and elevations of the subgrade are correct as shown on drawings. Where poor subgrade material is encountered, remove and replace with suitable material.
- B. Verify compacted subgrade is acceptable, ready to support imposed loads and paving, and ready to receive work.

3.02 SUBBASE PREPARATION

- A. Maintain subgrade in a smooth, compacted condition with required section and established grade until concrete is placed.
- B. See Section 32 11 20 for aggregate subbase.
- C. Apply primer on aggregate subbase at uniform rate of 1/3 gallon per square yard.

3.03 CONCRETE SIDEWALK AND WHEELCHAIR RAMP INSTALLATION

- A. Forming:
 - 1. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
 - 2. Sidewalk Forms: Place and secure forms to location, dimension, profile, and gradient shown on drawings. Height equal to the full depth of the finished sidewalk.
 - 3. Wheelchair Ramps: Place and secure forms to location, dimension, profile, and gradient shown on drawings. Comply with ADA Standards.
- B. Reinforcement:
 - 1. Place wire-mesh reinforcement mid-height of forms.
 - 2. Uniformly add fiber reinforcement to concrete mix according to manufacturer's recommendations.

- C. Placement:
 - 1. Place concrete in a single lift.
 - 2. Consolidate concrete by tamping and spading.
- D. Joints:
 - 1. Spacing: Provide scored joints every 10 feet (3 m).
 - 2. Filler height equal to the full depth of the finished concrete.
- E. Finishing:
 - 1. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge, 1/4 inch radius.
 - 2. Wheelchair Ramps: Broomed perpendicular to slope.
 - 3. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.
 - 4. Place surface sealer on exposed concrete surfaces after hardening. Apply in accordance with manufacturer's instructions.

END OF SECTION

**SECTION 32 17 23
PAVEMENT MARKINGS**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Painted pavement markings.
- B. Plastic pavement markings.

1.02 RELATED REQUIREMENTS

- A. Section 32 12 16 - Asphalt Paving.
- B. Section 32 13 13 - Concrete Paving.
- C. Section 32 16 23 - Sidewalks.

1.03 PRICE AND PAYMENT PROCEDURES

- A. Unit Prices:
 - 1. See Section 01 22 00 - Unit Prices for additional requirements.
 - 2. Basis of Measurement for Linear Painted or Plastic Pavement Markings: By linear foot.

1.04 REFERENCE STANDARDS

- A. AASHTO M 237 - Standard Specification for Epoxy Resin Adhesives for Bonding Traffic Markers to Hardened Portland Cement and Asphalt Concrete.
- B. AASHTO M 247 - Standard Specification for Glass Beads Used in Pavement Markings.
- C. AASHTO M 249 - Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form).
- D. AASHTO MP 24 - Standard Specification for Waterborne White and Yellow Traffic Paints.
- E. ASTM D4505 - Standard Specification for Preformed Retroreflective Pavement Marking Tape for Extended Service Life.
- F. ASTM E303 - Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester.
- G. FHWA MUTCD - Manual on Uniform Traffic Control Devices.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work of this section with adjoining work.

1.06 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used.
- C. Manufacturer's Instructions:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- D. Maintenance Materials: Furnish the following for Government's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience and approved by manufacturer.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver paint in containers of at least 5 gallons accompanied by batch certificate.

- B. Deliver glass beads in containers suitable for handling and strong enough to prevent loss during shipment, accompanied by batch certificate.
- C. Store products in manufacturer's unopened packaging until ready for installation.
- D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.09 FIELD CONDITIONS

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F or more than 95 degrees F.

1.10 SEQUENCING

- A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of markings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Painted Pavement Markings:
 - 1. Dunn-Edwards Corporation; Vin-L-Stripe Specialty Interior/Exterior Flat Zone Marking Paint.
 - 2. Dunn-Edwards Corporation; Vin-L-Stripe Specialty Interior/Exterior Velvet Zone Marking Paint.
- B. Plastic Pavement Markings:
 - 1. InSite Solutions, LLC; www.stop-painting.com/#sle.

2.02 PAINTED PAVEMENT MARKINGS

- A. Comply with State of Pennsylvania Highway Department standards.
- B. Comply with FHWA MUTCD.
- C. Painted Pavement Markings: As indicated on drawings.
 - 1. Marking Paint: In accordance with AASHTO MP 24.
 - a. Parking Lots: Yellow.
 - b. Wheelchair Symbols: Provide blue and white.
 - 2. Reflective Glass Beads: Type 1, in accordance with AASHTO M 247.
 - 3. Obliterating Paint: Type I, in accordance with AASHTO MP 24.
 - a. Bituminous Pavement: Black.
 - b. Concrete Pavement: Gray.

2.03 PLASTIC PAVEMENT MARKINGS

- A. Comply with State of Pennsylvania Highway Department standards.
- B. Comply with FHWA MUTCD.
- C. Plastic Pavement Markings: Preformed, uniform, smooth edges.
 - 1. Marking Tape: Vinyl, with retroreflective beads, in accordance with ASTM D4505.
 - a. Class: Class 1, in accordance with ASTM D4505.
 - b. Color: Yellow.
 - c. Retroreflectivity: Retroreflectivity II, in accordance with ASTM D4505.
 - d. Skid Resistance: Level B, in accordance with ASTM E303.
 - e. Thickness: 60 mils, 0.06 inch (1.5 mm).
 - f. Width: 4 inches (102 mm).
 - g. Primer: As recommended by manufacturer.
 - 2. Thermoplastic Markings: Alkyd, in accordance with AASHTO M 249.
 - a. Color: Yellow.
 - b. Reflective Glass Beads: Type 1, in accordance with AASHTO M 247.

- c. Existing-Pavement Primer: Asphalt, thermosetting adhesive.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Identify existing markings for removal.
- B. Verification of Conditions: Verify that pavement is dry and ready for installation.
- C. Notify Contracting Officer or Contracting Officer's Representative of unsatisfactory conditions before proceeding.

3.02 PREPARATION

- A. Establish survey control points for locating and dimensioning of markings.
- B. Place barricades, warning signs, and flags as necessary to alert approaching traffic.
- C. Clean surfaces prior to installation.
 - 1. Remove dust, dirt, and other debris.
 - 2. Remove rubber deposits, existing paint markings, and other coatings.
- D. Temporary Markings: Apply as directed by Contracting Officer or Contracting Officer's Representative.
- E. Apply paint stencils by type and color at necessary intervals.

3.03 INSTALLATION

- A. General:
 - 1. Position pavement markings as indicated on drawings.
 - 2. Field location adjustments require approval of Contracting Officer or Contracting Officer's Representative.
 - 3. Allow traffic movement without hindrance.
- B. Painted Pavement Markings:
 - 1. Apply in accordance with manufacturer's instructions.
 - 2. Apply in accordance with State of Pennsylvania Highway Department standards.
 - 3. Apply in accordance with FHWA MUTCD standards.
 - 4. Obliterating Paint: Apply as necessary to cover existing markings completely.
 - 5. Marking Paint: Apply uniformly, with sharp edges.
 - a. Applications: One coat.
 - b. Wet Film Thickness: 0.015 inch, minimum.
 - c. Stencils: Lay flat against pavement, align with striping, remove after application.
 - d. Glass Beads: Apply directly to paint, 10 second lag time, 6 lbs/gal of paint, uniform thickness and coverage.
 - e. Length Tolerance: Plus or minus 3 inches.
 - f. Width Tolerance: Plus or minus 1/8 inch.
- C. Plastic Pavement Markings:
 - 1. Install in accordance with manufacturer's instructions in manner necessary to maintain manufacturer's warranty.
 - 2. Install in accordance with State of **Pennsylvania** Highway Department standards.
 - 3. Install in accordance with FHWA MUTCD standards.
 - 4. Marking Tape: Place tape on pavement smooth and without wrinkles. 1/4 inch (6 mm) maximum gap between adjacent pieces. Immediately apply uniform pressure until firmly adhered.
 - a. Apply primer to pavement at a rate of 1 oz/sq ft (3 L/sq m) and allow to set for 10 minutes prior to taping.
 - 5. Thermoplastic Markings: Preheat pavement surface to 275 degrees F (135 degrees C). Place markings on pavement smooth and without wrinkles. 1/4 inch (6 mm) maximum gap between adjacent markings. Uniformly heat markings between 400 degrees F (204

degrees C) to 440 degrees F (227 degrees C). Do not overheat, scorch, or disperse embedded glass beads.

- a. Apply primer according to manufacturer's recommendations.

3.04 TOLERANCES

- A. Maximum Variation From True Position: 3 inches (76 mm).
- B. Maximum Offset From True Alignment: 3 inches (76 mm).

3.05 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Perform field inspection for deviations from true alignment or material irregularities.
- C. If inspections indicate work does not meet specified requirements, rework and reinspect at no cost to Government.
- D. Allow the pavement marking to set at least the minimum time recommended by manufacturer.

3.06 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals for additional requirements.
- B. Temporary Markings: Remove without damaging surfaces.

3.07 PROTECTION

- A. Prevent approaching traffic from crossing newly applied pavement markings.
- B. Replace damaged or removed markings at no additional cost to Government.
- C. Preserve survey control points until pavement marking acceptance.

END OF SECTION

**SECTION 32 17 26
TACTILE WARNING SURFACING**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Cast iron tactile warning surfacing.
- B. Plastic tactile warning surfacing.

1.02 PRICE AND PAYMENT PROCEDURES

- A. Unit Prices:
 - 1. See Section 01 22 00 - Unit Prices for additional requirements.
 - 2. Basis of Measurement for Tiles: By linear foot.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design.
- B. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
- C. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- D. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- E. ASTM C501 - Standard Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser.
- F. ASTM C903 - Standard Practice for Preparing Refractory Specimens by Cold Gunning.
- G. ASTM D570 - Standard Test Method for Water Absorption of Plastics.
- H. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.
- I. ASTM D695 - Standard Test Method for Compressive Properties of Rigid Plastics.
- J. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- K. ASTM D2047 - Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine.
- L. ASTM G155 - Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials.
- M. ATBCB PROWAG - Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way.
- N. SAE AMS-STD-595 - Colors Used in Government Procurement.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's product data, standard details, details specific to this project, written installation, and maintenance instructions.
- C. Shop Drawings: Submit plan and detail drawings. Indicate:
 - 1. Locations on project site. Demonstrate compliance with referenced accessibility standards.
 - 2. Sizes and layout.
 - 3. Pattern spacing and orientation.
 - 4. Attachment and fastener details, if applicable.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with minimum 3 years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver to project site in manufacturer's protective wrapping and in manufacturer's unopened packaging.
- B. Store covered and elevated above grade and in manufacturer's unopened packaging until ready for installation. Maintain at ambient temperature between 40 and 90 degrees F.

1.07 FIELD CONDITIONS

- A. Ambient Conditions: Do not install tiles when ambient air temperature is below manufacturer's recommendations.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Cast Iron Tactile Warning Surfacing:
 - 1. ADA Solutions, a division of SureWerx USA: www.adatale.com/#sle.
 - 2. EqualTile, a brand of Advanced Roadway Manufacturing, Inc: www.equaltile.com/#sle.
 - 3. EJ: www.ejco.com/#sle.
 - 4. Neenah Foundry, a division of Neenah Enterprises, Inc: www.nfco.com/#sle.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Low-Profile Detectable Warning Tiles:
 - 1. EqualTile, a brand of Advanced Roadway Manufacturing, Inc: www.equaltile.com/#sle.
- C. Retrofit Detectable Warning Plates:
 - 1. EqualTile, a brand of Advanced Roadway Manufacturing, Inc: www.equaltile.com/#sle.

2.02 MATERIALS

- A. Cast Iron Tactile Warning Surfacing:
 - 1. Material: Gray cast iron; ASTM A48/A48M, Class 30 A, minimum.
 - 2. Shape: Rectangular and radius.
 - 3. Square Dimensions: 24 inches square.
 - 4. Radius Dimensions: 24 inches wide, 9-foot, 5-inch radius.
 - 5. Pattern: Truncated cones complying with ADA Standards.
 - 6. Joint: Manufacturer standard, bolted connection.
 - 7. Finish: Manufacturer's factory-applied powder coat.
 - 8. Color: As selected by Contracting Officer or Contracting Officer's Representative from manufacturer's standard range.
 - 9. Color: SAE AMS-STD-595, Table IV, Federal Yellow No.33538.
 - 10. Products:
 - a. Neenah Foundry, a division of Neenah Enterprises, Inc: www.nfco.com/#sle.

2.03 ACCESSORIES

- A. Fasteners: ASTM A666/A666M, Type 304 stainless steel.
 - 1. Type: Countersunk, color-matched composite sleeve anchors.
 - 2. Size: 1/4 inch diameter and 1-1/2 inches long.
- B. Sealant: Elastomeric sealant of color to match adjacent surfaces; approved by surfacing tile manufacturer.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. When installation location is near site boundary or property line, verify required location using property survey.
- B. Verify that work area is ready to receive work:
 - 1. Examine work area with installer present.
 - 2. If existing conditions are not as required to properly complete the work of this section, notify Contracting Officer or Contracting Officer's Representative.

3. Verify substrate is clean and dry, free of voids, projections, and loose material.
 4. Do not proceed with installation until deficiencies in existing conditions have been corrected.
 5. Concrete: See Section 32 16 23.
- C. Verify that dimensions, tolerances, and attachment methods for work in this section are properly coordinated with other work on site.

3.02 PREPARATION

- A. Surface Preparation:
1. Remove dust, oil, grease, curing compounds, sealers, and other substances that may interfere with adhesive bond or sealant adhesion.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's written instructions.
1. Do not install damaged, warped, bowed, dented, abraded, or otherwise defective units.
 2. Do not install when ambient or substrate temperature has been below 40 degrees F during the preceding 8 daylight hours.
- B. Field Adjustment:
1. Locate relative to curb line in accordance with ATBCB PROWAG, Sections 304 and 305.
 2. Orient so dome pattern is aligned with the direction of ramp.
- C. Install units fully seated to substrate, square to straight edges and flat to required slope.
- D. Align units so that tops of adjacent units are flush and joints between units are uniform in width.
- E. Cast in Place:
1. When installing multiple adjacent units, leave 3/16-inch gap between units to allow for expansion.
 2. Tamp and vibrate units as recommended by manufacturer.
 3. Place and position weights on units while concrete cures.
 4. Ensure no voids or air pockets exist between top surface of concrete and underside of units.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Inspect for raised edges and misalignment.
- C. Nonconforming Work: Remove and replace.

3.05 CLEANING

- A. Remove protective plastic sheeting within 24 hours of installation.
- B. Remove excess sealant or adhesive from joints and edges.
- C. Clean four days prior to date of scheduled inspection.

3.06 PROTECTION

- A. Protect installed units from traffic, subsequent construction operations or other imposed loads until concrete is fully cured.
- B. Touch-up, repair or replace damaged products prior to Date of Substantial Completion.

END OF SECTION

**SECTION 32 33 00
SITE FURNISHINGS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Bollards.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Bollard infill and underground encasement.
- B. Section 05 50 00 - Metal Fabrications: Anchors to attach site furnishings to mounting surfaces.
- C. Section 05 50 00 - Metal Fabrications: Utilitarian concrete filled steel pipe bollards.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design.
- B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- C. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- D. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- E. ASTM A536 - Standard Specification for Ductile Iron Castings.
- F. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- G. ASTM B26/B26M - Standard Specification for Aluminum-Alloy Sand Castings.
- H. ASTM B211 - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's specifications and descriptive literature, installation instructions, and maintenance information.
- C. Shop Drawings: Indicate plans for each unit or group of units, elevations with model number, overall dimensions, construction, and anchorage details.

1.05 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide manufacturer's Lifetime Warranty against defects in materials or workmanship for wood benches manufactured from solid teak.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Steel Pipe Bollards:
 - 1. FairWeather Site Furnishings: www.fairweathersf.com/#sle.
 - 2. Huntco Supply, LLC: www.huntco.com/#sle.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 BOLLARDS

- A. Steel Pipe Bollards: Hollow steel pipe with plain shaft.
 - 1. Materials:
 - a. Steel Pipe: ASTM A53/A53M, standard weight.
 - b. Factory Finish: Primed.
 - c. Color: As selected by Contracting Officer or Contracting Officer's Representative from manufacturer's standard range.

2. Mounting: In-ground.
3. Products:
 - a. Fair Weather Site Furnishings: www.fairweathersf.com/#sle.
 - b. Huntco Supply, LLC: www.huntco.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify proper installation of mounting surfaces, preinstalled anchor bolts, and other mounting devices; and ready to receive site furnishing items.
- B. See Section 05 50 00 for anchors to attach site furnishings to mounting surfaces.
- C. Do not begin installation until unacceptable conditions are corrected.

3.02 INSTALLATION

- A. Install site furnishings in accordance with approved shop drawings, and manufacturer's installation instructions.
- B. See Section 03 30 00 for bollard infill and underground encasement.
- C. Provide level mounting surfaces for site furnishing items.

END OF SECTION

**SECTION 32 92 19
SEEDING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Preparation of subsoil.
- B. Placing topsoil.
- C. Seeding, mulching and fertilizer.
- D. Maintenance.

1.02 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading: Topsoil material.
- B. Section 31 22 00 - Grading: Preparation of subsoil and placement of topsoil in preparation for the work of this section.
- C. Section 31 23 23 - Fill: Topsoil material.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
- B. Topsoil:
 - 1. Basis of Measurement: By the cubic yard.
 - 2. Basis of Payment: Includes topsoil, placing topsoil.
- C. Grassed Areas:
 - 1. Basis of Measurement: By the square yard.
 - 2. Basis of Payment: Includes preparation of subsoil, placing topsoil, seeding, watering and maintenance to specified time limit.

1.04 DEFINITIONS

- A. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Topsoil samples.
- C. Certificate: Certify seed mixture approval by authority having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable. Deliver seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.
- B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

PART 2 PRODUCTS**2.01 REGULATORY REQUIREMENTS**

- A. Comply with regulatory agencies for fertilizer and herbicide composition.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of seed mixture.

2.02 SEED MIXTURE

- A. Seed Mixture:

1. Merion Blue Grass: 20 percent.
2. Kentucky Blue Grass: 35 percent.
3. Creeping Red Fescue Grass: 30 percent.
4. Norlea Perennial Rye: 15 percent.

2.03 SOIL MATERIALS

- A. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0.
- B. Topsoil: Excavated from site and free of weeds.

2.04 ACCESSORIES

- A. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.
- B. Fertilizer: recommended for grass, with fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, to the following proportions:
 1. Nitrogen: 20 percent.
 2. Phosphoric Acid: 5 percent.
 3. Soluble Potash: 10 percent.
- C. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.
- D. Erosion Fabric: Jute matting, open weave.

2.05 TESTS

- A. Provide analysis of topsoil fill under provisions of Section 01 40 00.
- B. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.
- C. Submit minimum 10 oz sample of topsoil proposed. Forward sample to approved testing laboratory in sealed containers to prevent contamination.
- D. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that prepared soil base is ready to receive the work of this Section.

3.02 PREPARATION

- A. Prepare subgrade in accordance with Section 31 22 00.
- B. Place topsoil in accordance with Section 31 22 00.

3.03 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions.
- B. Apply after smooth raking of topsoil and prior to roller compaction.
- C. Do not apply fertilizer at same time or with same machine as will be used to apply seed.
- D. Mix thoroughly into upper 2 inches of topsoil.
- E. Lightly water to aid the dissipation of fertilizer.

3.04 SEEDING

- A. Apply seed at a rate of 4 lbs per 1000 sq ft evenly in two intersecting directions. Rake in lightly.
- B. Do not seed areas in excess of that which can be mulched on same day.

- C. Do not sow immediately following rain, when ground is too dry, or during windy periods.
- D. Immediately following seeding and compacting, apply mulch to a thickness of 1/8 inches. Maintain clear of shrubs and trees.
- E. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.
- F. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches.

3.05 MAINTENANCE

- A. Provide maintenance at no extra cost to Government; Government will pay for water.
- B. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.
- C. Mow grass at regular intervals to maintain at a maximum height of 2-1/2 inches. Do not cut more than 1/3 of grass blade at any one mowing.
- D. Neatly trim edges and hand clip where necessary.
- E. Immediately remove clippings after mowing and trimming.
- F. Water to prevent grass and soil from drying out.
- G. Roll surface to remove minor depressions or irregularities.
- H. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
- I. Immediately reseed areas that show bare spots.
- J. Protect seeded areas with warning signs during maintenance period.

END OF SECTION

SECTION 33 01 10.58
DISINFECTION OF WATER UTILITY PIPING SYSTEMS

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Disinfection of site domestic water lines and site fire water lines specified in Section 33 14 16.
- B. Testing and reporting results.

1.02 RELATED REQUIREMENTS

- A. Section 22 10 05 - Plumbing Piping: Disinfection of building domestic water piping system.
- B. Section 33 14 16 - Site Water Utility Distribution Piping.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
- B. Disinfection: By the linear foot. Includes preparing, disinfecting, testing, and reporting.

1.04 REFERENCE STANDARDS

- A. AWWA B300 - Hypochlorites.
- B. AWWA B301 - Liquid Chlorine.
- C. AWWA B302 - Ammonium Sulfate.
- D. AWWA B303 - Sodium Chlorite.
- E. AWWA C651 - Disinfecting Water Mains.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Test Reports: Indicate results comparative to specified requirements.
- C. Certificate: Certify that cleanliness of water distribution system meets or exceeds specified requirements.
- D. Disinfection report:
 - 1. Type and form of disinfectant used.
 - 2. Date and time of disinfectant injection start and time of completion.
 - 3. Test locations.
 - 4. Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
 - 5. Date and time of flushing start and completion.
 - 6. Disinfectant residual after flushing in ppm for each outlet tested.
- E. Bacteriological report:
 - 1. Date issued, project name, and testing laboratory name, address, and telephone number.
 - 2. Time and date of water sample collection.
 - 3. Name of person collecting samples.
 - 4. Test locations.
 - 5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
 - 6. Coliform bacteria test results for each outlet tested.
 - 7. Certification that water complies, or fails to comply, with bacterial standards of _____.

1.06 QUALITY ASSURANCE

- A. Testing Firm: Company specializing in testing potable water systems, certified by governing authorities of the Commonwealth of Pennsylvania.

PART 2 PRODUCTS**2.01 DISINFECTION CHEMICALS**

- A. Chemicals: AWWA B300 Hypochlorite, AWWA B301 Liquid Chlorine, AWWA B302 Ammonium Sulfate, and AWWA B303 Sodium Chlorite.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that piping system and water well has been cleaned, inspected , and pressure tested.
- B. Schedule disinfecting activity to coordinate with start-up, testing, adjusting and balancing, demonstration procedures, including related systems.

3.02 DISINFECTION

- A. Use method prescribed by the applicable state or local codes, or health authority or water purveyor having jurisdiction, or in the absence of any of these follow AWWA C651.
- B. Provide and attach equipment required to perform the work.
- C. Inject treatment disinfectant into piping system.
- D. Maintain disinfectant in system for 24 hours.
- E. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.
- F. Replace permanent system devices removed for disinfection.
- G. Pressure test system to 160 psi. Repair leaks and re-test.

3.03 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 40 00.
- B. Test samples in accordance with AWWA C651.

END OF SECTION

**SECTION 33 05 61
CONCRETE MANHOLES**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Monolithic concrete manholes with masonry transition to lid frame, covers, anchorage, and accessories.
- B. Modular precast concrete manhole sections with tongue-and-groove joints with masonry transition to lid frame, covers, anchorage, and accessories.
- C. Monolithic FRP manholes with transition to lid frame, covers, anchorage, and accessories.
- D. Masonry manhole sections with masonry transition to lid frame, covers, anchorage, and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 04 05 11 - Masonry Mortaring and Grouting.
- C. Section 04 20 00 - Unit Masonry: Masonry units and mortar and grout.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
- B. Manhole: By the unit. Includes excavating, concrete base pad, concrete manhole sections, FRP manhole sections, brick masonry manhole construction, brick masonry transition to cover frame, cover frame and cover, to indicated depth, forming and sealing pipe inlets and outlets.

1.04 REFERENCE STANDARDS

- A. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures.
- B. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
- C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- D. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
- E. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete.
- F. ASTM C55 - Standard Specification for Concrete Building Brick.
- G. ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale).
- H. ASTM C478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections.
- I. ASTM C478M - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections (Metric).
- J. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
- K. ASTM C923M - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals (Metric).
- L. ASTM C1634 - Standard Specification for Concrete Facing Brick and Other Concrete Masonry Facing Units.
- M. ASTM D3753 - Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Manholes and Wetwells.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide manhole covers, component construction, features, configuration, and dimensions.
- C. Shop Drawings: Indicate manhole locations, elevations, piping sizes and elevations of penetrations.
- D. Manufacturer's Qualification Statement.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.07 FIELD CONDITIONS

- A. Cold and Hot Weather Requirements: Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.
- B. Maintain materials and surrounding air temperature to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry work.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Manhole Sections: Reinforced precast concrete in accordance with ASTM C478 (ASTM C478M), with resilient connectors complying with ASTM C923 (ASTM C923M).
- B. Manhole Sections: ASTM D3753, glass-fiber reinforced polyester with integral steps.
- C. Concrete: As specified in Section 03 30 00.
- D. Concrete Brick Units: As specified in Section 04 20 00.
- E. Mortar and Grout: As specified in Section 04 20 00, Type S.
- F. Mortar and Grout: As specified in Section 04 05 11, Type S.
- G. Reinforcement: Formed steel wire, galvanized finish, wire diameter as indicated on drawings.
- H. Concrete Reinforcement: As specified in Section 03 30 00.
- I. Admixtures, General: Chemical type complying with ASTM C494/C494M (wet mix only).
- J. Air-Entraining Admixture: Complying with ASTM C260/C260M (wet mix only).
- K. Waterproofing Admixture:
 - 1. Manufacturers:
 - a. ConShield Technologies, Inc; Crystal X: www.conshield.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- L. Microbiologically-Induced Corrosion-Inhibiting Admixture: Resists growth of bacteria and fungi on or inside concrete.
 - 1. Manufacturers:
 - a. ConShield Technologies, Inc; ConShield HD: www.conshield.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COMPONENTS

- A. Frame and Cover: ASTM A48/A48M Class 30B cast iron construction, machined flat bearing surface; hinged; sealing gasket.
- B. Cover: Removable, lockable; closed cover design; cover molded with identifying name.
- C. Proof Load: Heavy duty.
 - 1. Manufacturers:
 - a. EJ; Manhole Cover: www.ejco.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Manhole Steps: Formed galvanized steel rungs; 3/4 inch diameter. Formed integral with manhole sections.

- E. Strap Anchors: Bent steel shape, ___ x ___ inch size x _____ inch thick, galvanized to ASTM A123/A123M Grade specified for applicable material category.

2.03 CONFIGURATION

- A. Shaft Construction: Concentric with concentric cone top section; lipped male/female dry joints; sleeved to receive pipe sections.
- B. Shape: Cylindrical.
- C. Clear Inside Dimensions: As indicated.
- D. Design Depth: As indicated.
- E. Clear Lid Opening: 26 inches diameter.
- F. Pipe Entry: Provide openings as indicated.
- G. Steps: 12 inches wide, 16 inches on center vertically, set into manhole wall.

2.04 ACCESSORIES

- A. Adjustment Riser: _____.
 - 1. Manufacturer:
 - a. EJ; INFRA-RISER ® Adjustment Riser: www.ejco.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify items provided by other sections of Work are properly sized and located.
- B. Verify that built-in items are in proper location, and ready for roughing into Work.
- C. Verify excavation for manholes is correct.

3.02 PREPARATION

- A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

3.03 MANHOLES

- A. Place concrete base pad, trowel top surface level.
- B. Place manhole sections plumb and level, trim to correct elevations, anchor to base pad.
- C. Form and place manhole cylinder plumb and level, to correct dimensions and elevations. As work progresses, build in fabricated metal items.
- D. Cut and fit for pipe.
- E. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour as required.
- F. Set cover frames and covers level without tipping, to correct elevations.
- G. Coordinate with other sections of work to provide correct size, shape, and location.

3.04 MASONRY WORK

- A. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- B. Lay masonry units in running bond. Course one unit and one mortar joint to equal 8 inches.
- C. Form concave mortar joints.
- D. Lay masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
- E. Install joint reinforcement 16 inches on center.
- F. Place joint reinforcement in first and second horizontal joints above base pad and below lid frame opening.

3.05 SCHEDULES

- A. Storm Sewer Manholes: Precast concrete sections, galvanized steel steps, 48 inch inside dimension, to depth indicated, with bolted lid.
- B. Electric Service Manholes: Prefabricated FRP sections, integral molded steps, 60 inch inside dimension, to depth indicated.

END OF SECTION

SECTION 33 14 16
SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Water pipe for site conveyance lines.
- B. Pipe valves.
- C. Fire hydrants.
- D. Backflow preventers - double check-valve assemblies.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete for thrust restraints.
- B. Section 09 91 13 - Exterior Painting.
- C. Section 21 11 00 - Facility Fire-Suppression Water-Service Piping.
- D. Section 26 05 83 - Wiring Connections.
- E. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.
- F. Section 33 01 10.58 - Disinfection of Water Utility Piping Systems: Disinfection of site service utility water piping.
- G. Section 33 05 61 - Concrete Manholes.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
- B. Pipe and Fittings: By the linear foot. Includes hand trimming excavation, pipe and fittings, bedding, concrete thrust restraints, connection to building service piping, and to municipal utility water source.
- C. Valves: By the unit. Includes valve, fittings and accessories.
- D. Hydrant: By the unit. Includes hand trimming excavation, gravel sump, hydrant, valve, connection, and accessories.

1.04 REFERENCE STANDARDS

- A. AASHTO HB - Standard Specifications for Highway Bridges.
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
- C. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250.
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- F. ASME B18.2.2 - Nuts for General Applications: Machine Screw Nuts; and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
- G. ASME B18.5.2.1M - Metric Round Head Short Square Neck Bolts.
- H. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies.
- I. ASSE 1015 - Performance Requirements for Double Check Backflow Prevention Assemblies.
- J. ASSE 1047 - Performance Requirements for Reduced Pressure Detector Backflow Prevention Assemblies.
- K. ASSE 1048 - Performance Requirements for Double Check Detector Backflow Prevention Assemblies.
- L. ASSE 1060 - Performance Requirements for Outdoor Enclosures for Fluid Conveying Components.

- M. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- N. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
- O. ASTM A563/A563M - Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric).
- P. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- Q. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- R. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- S. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- T. ASTM D2855 - Standard Practice for the Two-Step (Primer & Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
- U. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
- V. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals.
- W. ASTM F1267 - Standard Specification for Metal, Expanded, Steel.
- X. ASTM F1807 - Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps, for SDR9 Cross-Linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing.
- Y. ASTM F1960 - Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing.
- Z. ASTM F2080 - Standard Specification for Cold-Expansion Fittings with Metal Compression-Sleeves for Crosslinked Polyethylene (PEX) Pipe and SDR9 Polyethylene of Raised Temperature (PE-RT) Pipe.
- AA. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
- BB. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
- CC. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- DD. AWWA C115/A21.15 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
- EE. AWWA C200 - Steel Water Pipe, 6 in. (150 mm) and Larger.
- FF. AWWA C203 - Coal-Tar Protective Coatings and Linings for Steel Water Pipe.
- GG. AWWA C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe, 4 in. (100 mm) and Larger - Shop Applied.
- HH. AWWA C206 - Field Welding of Steel Water Pipe.
- II. AWWA C207 - Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm).
- JJ. AWWA C208 - Dimensions for Fabricated Steel Water Pipe Fittings.
- KK. AWWA C209 - Cold-Applied Tape Coatings for Steel Water Pipe, Special Sections, Connections, and Fittings.
- LL. AWWA C210 - Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings.
- MM. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.

- NN. AWWA C502 - Dry-Barrel Fire Hydrants.
- OO. AWWA C504 - Rubber-Seated Butterfly Valves.
- PP. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-In. Through 48-In. (50-mm Through 1,200-mm) NPS.
- QQ. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.
- RR. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
- SS. AWWA C602 - Cement-Mortar Lining of Water Pipelines in Place - 4 In. (100 mm) and Larger.
- TT. AWWA C606 - Grooved and Shouldered Joints.
- UU. AWWA C800 - Underground Service Line Valves and Fittings.
- VV. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.
- WW. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service.
- XX. AWWA C904 - Cross-Linked Polyethylene (PEX) Pressure Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service.
- YY. AWWA M11 - Steel Water Pipe - A Guide For Design and Installation.
- ZZ. NSF 61 - Drinking Water System Components - Health Effects.
- AAA. UL 246 - Hydrants for Fire-Protection Service.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with utility company requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers with labeling in place.
- B. Protect crosslinked polyethylene tubing from direct and indirect UV exposure.

1.08 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 WATER PIPE

- A. Ductile Iron Pipe: AWWA C151/A21.51:
 - 1. Fittings: Ductile iron, standard thickness.
 - 2. Joints: AWWA C111/A21.11, Styrene butadiene rubber (SBR) or vulcanized SBR gasket with rods.
 - 3. Jackets: AWWA C105/A21.5 polyethylene jacket.

2.02 VALVES

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Gate Valves 3 Inches and Over:

1. AWWA C500, iron body, bronze trim, non-rising stem with square nut, single wedge, flanged ends, control rod, post indicator, valve key, and extension box.
 2. AWWA C509, iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat, flanged ends, control rod, post indicator, valve key, and extension box.
- C. Swing Check Valves From 2 Inches to 24 Inches:
1. AWWA C508, iron body, bronze trim, 45 degree swing disc, renewable disc and seat, flanged ends.
- D. Butterfly Valves From 2 Inches to 24 Inches:
1. AWWA C504, iron body, bronze disc, resilient replaceable seat, water or lug ends, ten position lever handle.

2.03 HYDRANTS

- A. Hydrants: Type as required by utility company.
- B. Hydrants: AWWA C502, UL 246, dry barrel type.
1. Inside dimension: 7 inches minimum, with minimum 5 inches diameter valve seat opening.
 2. Minimum net water area of barrel not less than 190 percent of valve opening.
 3. 6 inch bell or mechanical joint inlet connection with accessories, gland bolts, and gaskets.
- C. Hydrant Extensions: Fabricate in multiples of 6 inches with rod and coupling to increase barrel length.
- D. Hose and Streamer Connection: Match sizes with utility company, two hose nozzles , one pumper nozzle.
- E. Pressure Rating: According to utility company.
- F. Finish: Primer and two coats of enamel in color required by utility company.

2.04 BACKFLOW PREVENTERS - DOUBLE CHECK-VALVE ASSEMBLIES

- A. Manufacturers:
1. Apollo Valves: www.apollovalves.com/#sle.
 2. MIFAB, Inc: www.mifab.com/#sle.
 3. Watts Regulator Company, a Part of Watts Water Technologies: www.wattsregulator.com/#sle.
 4. Zurn Industries, LLC: www.zurn.com/#sle.
- B. Double Check-Valve Assemblies 2-1/2 Inches NPS and Larger:
1. ASSE 1015; NSF 61; epoxy-coated cast iron body; two independently operating, spring-loaded check valves with stainless steel springs; integral test fittings.
 2. Size: 2-1/2- to 10-inch NPS assembly with flanged OS&Y gate valves.
 3. Accessories: Provide Y-strainer and test cocks.
- C. Double Check-Detector Assemblies:
1. ASSE 1048; NSF 61; epoxy-coated cast iron body; metered bypass, two independently operating, spring-loaded check valves with stainless steel springs; integral test fittings.
 2. Size: 2-1/2- to 10-inch NPS assembly with flanged OS&Y gate valves.
 3. Maximum Working Parameters: 175 psi at 140 degrees F.
 4. Accessories: Provide Y-strainer and test cocks.

2.05 BEDDING AND COVER MATERIALS

- A. Bedding: As specified in Section 31 23 16.13.
- B. Cover: As specified in Section 31 23 16.13.

2.06 ACCESSORIES

- A. Concrete for Thrust Restraints: Concrete type specified in Section 03 30 00.
- B. Manhole and Cover: Refer to Section 33 05 61.
- C. Casing Spacer: Stainless steel spacer designed to maintain pipe casing integrity.

1. Manufacturers:
 - a. Advance Products & Systems, LLC: www.apsonline.com/#sle.
- D. Outdoor Backflow Enclosures:
 1. Vandal and Damage Resistant, Caged:
 - a. Manufacturers:
 - 1) Guardian Enclosures: www.guardianenclosures.com/#sle.
 - 2) GuardShack Enclosures: www.guardshackenclosures.com/#sle.
 - 3) StrongBox: www.strongbox.com/#sle.
 - 4) Substitutions: See Section 01 60 00 - Product Requirements.
 - b. Description: Expanded metal enclosure to protect aboveground piping, specialties, and equipment from vandalism and damage.
 - c. Construction:
 - 1) Side and Top Panels: ASTM F1267, expanded metal, rigid construction throughout entire assembly, powder-coated finish.
 - 2) Dimensions: _____ inches long by _____ inches wide by _____ inches tall.
 - 3) Provide locking device and devices for attachment of enclosure to base.
 - 4) Precast Concrete Base:
 - (a) Overall size to extend base 6 inches beyond perimeter of enclosure.
 - (b) Minimum Thickness: 4 inches.
 - (c) Provide piping openings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

3.02 PREPARATION

- A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare pipe connections to equipment with flanges or unions.

3.03 TRENCHING

- A. See the sections on excavation and fill for additional requirements.
- B. Hand trim excavation for accurate placement of pipe to elevations indicated.
- C. Form and place concrete for pipe thrust restraints at each change of pipe direction. Place concrete to permit full access to pipe and pipe accessories. Provide _____ square feet thrust restraint bearing on subsoil.
- D. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.04 INSTALLATION - PIPE

- A. Maintain separation of water main from sewer piping in accordance with _____ code.
- B. Group piping with other site piping work whenever practical.
- C. Establish elevations of buried piping to ensure not less than 4 feet of cover.
- D. Install pipe to indicated elevation to within tolerance of 5/8 inches.
- E. Install ductile iron piping and fittings to AWWA C600.
- F. Install grooved and shouldered pipe joints to AWWA C606.
- G. Install crosslinked polyethylene tubing and fittings to AWWA C904.
- H. Route pipe in straight line.
- I. Install pipe to allow for expansion and contraction without stressing pipe or joints.

- J. Install access fittings to permit disinfection of water system performed under Section 33 01 10.58.
- K. Slope water pipe and position drains at low points.
- L. Install trace wire 6 inches above top of pipe; coordinate with Section 31 23 16.13.

3.05 INSTALLATION - VALVES, HYDRANTS, BACKFLOW PREVENTERS

- A. Set valves on solid bearing.
- B. Center and plumb valve box over valve. Set box cover flush with finished grade.
- C. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway in accordance with Section 21 11 00.
- D. Set hydrants to grade, with nozzles at least 20 inches above ground in accordance with Section 21 11 00.
- E. Locate control valve 4 inches away from hydrant.
- F. Provide a drainage pit 36 inches square by 24 inches deep filled with 2 inches washed gravel. Encase elbow of hydrant in gravel to 6 inches above drain opening. Do not connect drain opening to sewer.
- G. Paint hydrants in accordance with Section 09 91 13.
- H. Install backflow preventers in accordance with requirements of local water utility and local authority having jurisdiction.
- I. Support backflow preventer independently of surrounding pipe using pipe stanchions.

3.06 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Perform field inspection and testing in accordance with Section 01 40 00.
- C. Pressure test water piping to ____ pounds per square inch.
- D. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Government.

END OF SECTION

SECTION 33 31 13
SITE SANITARY SEWERAGE GRAVITY PIPING

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Sanitary sewerage drainage piping, fittings, and accessories.
- B. Connection of building sanitary drainage system to municipal sewers.
- C. Cleanout access.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.
- B. Section 31 23 16 - Excavation: Excavating of trenches.
- C. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
- B. Cleanout:
 - 1. Basis of Measurement: By the unit for a nominal depth of ____ feet.
 - 2. Basis of Payment: Includes hand trimming excavating, foundation pad, unit installation with accessories, connection to sewer piping.

1.04 DEFINITIONS

- A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.05 REFERENCE STANDARDS

- A. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
- B. ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe.
- C. ASTM C12 - Standard Practice for Installing Vitrified Clay Pipe Lines.
- D. ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
- E. ASTM C14M - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, Culvert Pipe and (Metric).
- F. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- G. ASTM C76M - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric).
- H. ASTM C425 - Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
- I. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
- J. ASTM C443M - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric).
- K. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- L. ASTM C700 - Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
- M. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- N. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

- O. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.
- P. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- Q. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- R. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Material.
- S. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

1.06 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating pipe, pipe accessories.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- E. Field Quality Control Submittals: Document results of field quality control testing.
- F. Project Record Documents:
 - 1. Record location of pipe runs, connections, manholes, cleanouts, and invert elevations.
 - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.01 SEWER PIPE MATERIALS

- A. Provide products that comply with applicable code(s).
- B. Ductile Iron Pipe: ASTM A746, Pressure Class 350, with asphaltic lining, inside nominal diameter of 8 inches, bell and spigot end.
- C. Joint Seals for Ductile Iron Pipe: AWWA C111/A21.11; styrene butadiene rubber (SBR) or vulcanized SBR gaskets.
- D. Joint Seals: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.
- E. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.02 PIPE ACCESSORIES

- A. Casing Spacer: Polyethylene spacer designed to maintain pipe casing integrity.
 - 1. Manufacturers:
 - a. Advance Products & Systems, LLC: www.apsonline.com/#sle.

2.03 CLEANOUT MANHOLE

- A. Lid and Frame: Cast iron construction, hinged lid.
 - 1. Lid Design: Open checkerboard grille.
 - 2. Nominal Lid and Frame Size: 26 inches.
- B. Shaft Construction and Concentric Cone Top Section: Reinforced precast Concrete pipe sections, lipped male/female dry joints, cast steel ladder rungs into shaft sections at 12 inches; nominal shaft diameter of 36 inches.
- C. Base Pad: Cast-in-place concrete of type specified in Section 03 30 00, levelled top surface to receive concrete shaft sections, sleeved to receive sanitary sewer pipe sections.

2.04 BEDDING AND COVER MATERIALS

- A. Pipe Bedding Material: As specified in Section 31 23 23.
- B. Pipe Cover Material: As specified in Section 31 23 23.

PART 3 EXECUTION**3.01 GENERAL**

- A. Perform work in accordance with applicable code(s).

3.02 TRENCHING

- A. See Section 31 23 16.13 for additional requirements.
- B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.03 INSTALLATION - PIPE

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.
- B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
- C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch in 10 feet.
- D. Connect to building sanitary sewer outlet and municipal sewer system , through installed sleeves.
- E. Install trace wire 6 inches above top of pipe; coordinate with Section 31 23 16.13.

3.04 INSTALLATION - CLEANOUTS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.
- C. Establish elevations and pipe inverts for inlets and outlets as indicated.
- D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.05 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 40 00.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Government.

3.06 PROTECTION

- A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

**SECTION 33 42 11
STORMWATER GRAVITY PIPING**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Storm drainage piping, fittings, and accessories.
- B. Connection of drainage system to municipal sewers.
- C. Catch basins, Trench drains, Plant area drains, Paved area drainage, Site surface drainage, Detention tank, and Detention basin.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.
- B. Section 31 23 16 - Excavation: Excavating of trenches.
- C. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.
- D. Section 33 05 61 - Concrete Manholes.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
- B. Pipe and Fittings:
 - 1. Basis of Measurement: By the linear foot.
 - 2. Basis of Payment: Includes hand trimming excavation, bedding and backfilling, pipe and fittings, connection to building service piping and to municipal sewer.
- C. Catch Basins and Cleanouts:
 - 1. Basis of Measurement: By the unit for a nominal depth of ____ feet.
 - 2. Basis of Payment: Includes hand trimming excavating, bedding and backfilling, foundation pad, unit installation with accessories, connection to sewer piping.

1.04 DEFINITIONS

- A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.05 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines.
- B. AASHTO M 36 - Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.
- C. AASHTO M 252 - Standard Specification for Corrugated Polyethylene Drainage Pipe.
- D. AASHTO M 294 - Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-MM (12- to 60-in.) Diameter.
- E. ADA Standards - 2010 ADA Standards for Accessible Design.
- F. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
- G. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
- H. ASTM C12 - Standard Practice for Installing Vitrified Clay Pipe Lines.
- I. ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
- J. ASTM C14M - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, Culvert Pipe and (Metric).
- K. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

- L. ASTM C76M - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric).
- M. ASTM C425 - Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
- N. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
- O. ASTM C443M - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric).
- P. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- Q. ASTM C700 - Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
- R. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- S. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
- T. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.
- U. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- V. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- W. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Material.
- X. DIN EN 1433 - Drainage Channels for Vehicular and Pedestrian Areas - Classification, Design and Testing Requirements; Marking and Evaluation of Conformity.
- Y. DIN 19580 - Drainage channels for vehicular and pedestrian areas - Durability, mass per unit area and evaluation of conformity.

1.06 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of the storm with size, location and installation of service utilities.
- B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- C. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.07 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating pipe, pipe accessories.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- E. Field Quality Control Submittals: Document results of field quality control testing.
- F. Project Record Documents:
 - 1. Record location of pipe runs, connections, catch basins, cleanouts, and invert elevations.
 - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Comply with applicable code for materials and installation of the Work of this section.

2.02 SEWER PIPE MATERIALS

- A. Provide products that comply with applicable code(s).
- B. Concrete Pipe Joint Devices: ASTM C443 (ASTM C443M) rubber compression gasket joint.
- C. Concrete Pipe: Reinforced, ASTM C76 (ASTM C76M), Class II with Wall type A; mesh reinforcement; inside nominal diameter of ____ inches, bell and spigot end joints.
- D. Reinforced Concrete Pipe Joint Device: ASTM C443 (ASTM C443M) rubber compression gasket joint.
- E. Plastic Pipe: ASTM D2680, Acrylonitrile-Butadiene-Styrene (ABS) material; inside nominal diameter of ____ inches, bell and spigot style solvent sealed joint end.
- F. Plastic Pipe: ASTM D2729, Poly Vinyl Chloride (PVC) material; inside nominal diameter of ____ inches, bell and spigot style solvent sealed joint end.
- G. Plastic Pipe: ASTM D3034, Type PSM, Poly Vinyl Chloride (PVC) material; inside nominal diameter of ____ inches, bell and spigot style solvent sealed joint end.
- H. Plastic Pipe: ASTM D1785, Schedule 40, Poly Vinyl Chloride (PVC) material; inside nominal diameter of ____ inches, bell and spigot style solvent sealed joint end.
- I. Plastic Pipe: ASTM D3350, SDR 11; High Density Polyethylene (HDPE) solid wall pipe; inside nominal diameter of ____ inch, with cell classification of 335434C or better, thermal butt fusion joints in accordance with manufacturer's recommendations.
- J. Plastic Pipe: ASTM D3350, High Density Polyethylene (HDPE) corrugated wall pipe with integrally formed smooth liner; inside nominal diameter of ____ inch, meeting the requirements of AASHTO M 252, Type S, for diameters between 3 inches and 10 inches and AASHTO M 294, Type S, for diameters between 12 inches and 60 inches, soil-tight, bell and spigot joints with rubber gaskets, with pipe and fittings manufactured from virgin PE compounds with cell classification 3254420C.

2.03 PIPE ACCESSORIES

- A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.
- B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.
- C. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Storm Sewer Service " in large letters.
- D. Downspout Boots: Smooth interior without boxed corners or choke points; include integral lug slots, integral cleanout, cleanout cover, and tamper proof fasteners.
 - 1. Configuration: Angular.
 - 2. Material: Cast iron; ASTM A48/A48M; casting thickness 3/8 inch (9.5 mm), minimum.
 - 3. Finish: Manufacturer's standard factory applied powder coat finish.
 - 4. Color: To be selected by Contracting Officer or Contracting Officer's Representative from manufacturer's standard range.
 - 5. Accessories: Manufacturer's standard stainless steel fasteners, stainless steel building wall anchors, integral neoprene gaskets, and rubber coupling.
 - 6. Manufacturers:
 - a. Downspoutboots.com, a division of J. R. Hoe & Sons:
www.downspoutboots.com/#sle.

2.04 CATCH BASIN, TRENCH DRAIN, CLEANOUT, AND AREA DRAIN COMPONENTS

- A. Lids and Drain Covers: Cast iron; medium duty proof load; lockable; hinged.
 - 1. Catch Basin:
 - a. Nominal Lid and Frame Size: 24 by 48 inch.
 - 2. Area Drain:
 - a. Nominal Lid and Frame Size: 24 by 24 inch.

- B. Shaft Construction and Concentric Cone Top Section: Reinforced precast concrete pipe sections, lipped male/female dry joints, nominal shaft diameter of 48 inches.
- C. Base Pad: Cast-in-place concrete of type specified in Section 03 30 00, levelled top surface to receive concrete shaft sections, sleeved to receive sanitary sewer pipe sections.

2.05 BEDDING AND COVER MATERIALS

- A. Bedding: As specified in .
- B. Cover: As specified in Section 31 23 16.13.

PART 3 EXECUTION

3.01 TRENCHING

- A. See Section 31 23 16.13 - Trenching for additional requirements.
- B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.02 INSTALLATION - PIPE

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.
- B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
 - 1. Plastic Pipe: Also comply with ASTM D2321.
- C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch in 10 feet.
- D. Connect to building storm drainage system, foundation drainage system, and utility/municipal sewer system.
- E. Make connections through walls through sleeved openings, where provided.
- F. Install continuous trace wire 6 inches above top of pipe; coordinate with Section 31 23 16.13.

3.03 INSTALLATION - CATCH BASINS, TRENCH DRAINS AND CLEANOUTS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.
- C. Level top surface of base pad; sleeve concrete shaft sections to receive storm sewer pipe sections.
- D. Establish elevations and pipe inverts for inlets and outlets as indicated.
- E. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.04 FIELD QUALITY CONTROL

- A. Perform field inspection in accordance with Section 01 40 00 - Quality Requirements.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Government.

3.05 PROTECTION

- A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

**SECTION 33 52 16
GAS HYDROCARBON PIPING**

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Pipe and fittings for natural gas distribution on site outside buildings.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Foundations for storage tanks.
- B. Section 31 23 16 - Excavation: Excavating of trenches.
- C. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.
- D. Section 31 23 23 - Fill: Bedding and backfilling.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.

1.04 REFERENCE STANDARDS

- A. ANSI Z223.1 - National Fuel Gas Code.
- B. ASME B31.8 - Gas Transmission and Distribution Piping Systems.
- C. ASTM D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings.
- D. NFPA 58 - Liquefied Petroleum Gas Code.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Project Record Documents: Record actual locations of pipe mains, valves, connections, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with utility company requirements.
- B. Comply with NFPA 58.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers with labeling in place.

PART 2 PRODUCTS**2.01 PIPE**

- A. Polyethylene Pipe: ASTM D2513, SDR11:
 - 1. Fittings: ASTM D2513.
 - 2. Joints: Mechanical or compression fit.
- B. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Natural Gas Service " in large letters.

2.02 GAS COCKS AND VALVES

- A. Gas Cock and Pressure Regulating Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Gas Cocks Up to 2 Inches: 150 psig water or gas (WOG), bronze body, bronze tapered plug, non-lubricated, Teflon packing, threaded ends with cast iron curb box, cover, and key.

2.03 BEDDING AND COVER MATERIALS

- A. Bedding: As specified in Section 31 23 16.13.
- B. Cover: As specified in Section 31 23 16.13.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that building service connection and utility gas main size, location and invert are as indicated.

3.02 PREPARATION

- A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs. Bevel plain end ferrous pipe over 2 inches diameter Thread ferrous pipe 2 inches diameter and under.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections with flanges and unions.

3.03 TRENCHING

- A. See Section 31 23 16.13 for additional requirements.
- B. Hand trim excavation for accurate placement of pipe to elevations indicated.
- C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.04 INSTALLATION - PIPING

- A. Group piping with other site piping work whenever practical.
- B. Route piping in straight line.
- C. Install piping to conserve space and not interfere with use of site space.
- D. Install piping to allow for expansion and contraction without stressing pipe or joints.
- E. Install cocks and other fittings.
- F. Establish elevations of buried piping to ensure not less than 24 inches of cover in non-travelled areas and 48 inches of cover in driveways and parking areas.
- G. Install trace wire 6 inches above top of pipe; coordinate with Section 31 23 16.13.
- H. Center and plumb valve box over valve. Set box cover flush with finished ground surface. Prevent shock or stress from being transmitted through valve box to valve.
- I. Wrap valve and valve box with polyethylene tape and heat shrink.
- J. Paint valves and valve boxes with rust inhibitive primer and one coat of epoxy paint.

3.05 SERVICE CONNECTIONS

- A. Provide sleeve in foundation wall for gas service main. Seal enlarged sleeve watertight.
- B. Anchor service main to interior surface of foundation wall.
- C. Install service regulator adjacent to building wall in specified location.
- D. Install service regulator and riser pipe to prevent undue stress upon service pipe. For plastic service pipe, use steel pipe riser from below ground to regulator.

3.06 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 40 00.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Government.

END OF SECTION

SECTION 33 71 19
ELECTRICAL UNDERGROUND DUCTS, DUCTBANKS, AND MANHOLES

PART 1 GENERAL**1.01 SECTION INCLUDES**

- A. Conduit and duct:
 - 1. Rigid polyvinyl chloride (PVC) conduit.
- B. Precast concrete manholes.
- C. Cast-in-place manhole accessories.
- D. Accessories:
 - 1. Underground warning tape.

1.02 RELATED REQUIREMENTS

- A. Section 03 10 00 - Concrete Forming and Accessories.
- B. Section 03 20 00 - Concrete Reinforcing.
- C. Section 03 30 00 - Cast-in-Place Concrete.
- D. Section 07 11 13 - Bituminous Dampproofing.
- E. Section 22 10 06 - Plumbing Piping Specialties.
- F. Section 31 23 16 - Excavation.
- G. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.
- H. Section 31 23 23 - Fill: Bedding and backfilling.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
- B. Ductbank:
 - 1. Basis of Measurement: By the lineal foot (meter), for each configuration.
- C. Manhole:
 - 1. Basis of Measurement: Per unit.

1.04 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC).
- B. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
- C. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
- D. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.
- E. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
- F. ASTM C1037 - Standard Practice for Inspection of Underground Precast Concrete Utility Structures.
- G. ASTM D1002 - Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal).
- H. ASTM D1598 - Standard Test Methods for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure.
- I. ASTM D1599 - Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings.
- J. ASTM F512 - Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation.
- K. IEEE C2 - National Electrical Safety Code.

- L. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- M. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit.
- N. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
- O. NEMA BI 50063 - Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations.
- P. NEMA TC 7 - Solid-Wall Coilable and Straight Electrical Polyethylene Conduit.
- Q. NEMA TC 9 - Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.
- R. NFPA 70 - National Electrical Code.
- S. UL 6 - Electrical Rigid Metal Conduit-Steel.
- T. UL 514B - Conduit, Tubing, and Cable Fittings.
- U. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
- V. UL 651A - Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit.
- W. UL 746C - Polymeric Materials – Use in Electrical Equipment Evaluations.
- X. UL 2420 - Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
- Y. UL 2515 - Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for metallic conduit, nonmetallic conduit, and manhole accessories.
- C. Shop Drawings: Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast manholes.
- D. Project Record Documents: Record actual routing and elevations of underground conduit and duct, and locations and sizes of manholes.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 CONDUIT AND DUCT

- A. Rigid Polyvinyl Chloride (PVC) Conduit: NFPA 70, Type PVC; comply with NEMA TC 2 and list and label as complying with UL 651; Schedule 40 unless otherwise indicated; rated for use with conductors rated 90 degrees C.
 - 1. Manufacturers:
 - a. Cantex Inc: www.cantexinc.com/#sle.
 - b. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com/#sle.
 - c. JM Eagle: www.jmeagle.com/#sle.
 - 2. Fittings: Comply with NEMA TC 3 and list and label as complying with UL 651.
 - a. Manufacturer: Same as manufacturer of conduit to be connected.

2.02 PRECAST CONCRETE MANHOLES

- A. Description: Precast manhole designed in accordance with ASTM C858, comprising modular, interlocking sections complete with accessories.
- B. Loading: ASTM C857, Class A-16.

- C. Shape: Square.
- D. Base Section: Include 3 inch deep x 14 inch round sump with cast sleeve, and two 1 inch ground rod openings.
- E. Top Section: Include 39 inch diameter grooved opening for frame and cover.
- F. Riser Casting: 6 inch, with manhole step cast into frame.
- G. Frames and Covers: ASTM A48/A48M; Class 30B gray cast iron, 27 inch size, machine finished with flat bearing surfaces. Provide cover marked ELECTRIC to indicate utility.
- H. Cable Pulling Irons: Use galvanized rod and hardware. Locate opposite each duct entry. Provide watertight seal.
- I. Cable Rack Inserts: Minimum load rating of 800 pounds (365 kg). Locate at 3 feet on center.
- J. Cable Rack Mounting Channel: 1-1/2 x 3/4 inch steel channel, 48 inch length. Provide cable rack arm mounting slots on 1-1/2 inch centers.
- K. Cable Racks: Steel channel, 1-1/2 x 3/4 x 14 inches, with fastener to match mounting channel.
- L. Cable Supports: Porcelain clamps and saddles.
- M. Manhole Steps: Polypropylene plastic manhole step with 1/2-inch steel reinforcement.
- N. Sump Covers: ASTM A48/A48M; Class 30B gray cast iron.

2.03 ACCESSORIES

- A. Duct Bank Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for concrete encasement in open trench installation; suitable for the conduit/duct arrangement to be installed.
 - 1. Products:
 - a. Advance Products & Systems, LLC; Duct Bank Spacers: www.apsonline.com/#sle.
- B. Bore Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for installation within casing; furnished with roller wheels to facilitate installation, openings to facilitate grout flow, and holes for stabilization cable; suitable for the casing and conduit/duct arrangement to be installed.
 - 1. Products:
 - a. Advance Products & Systems, LLC; Bore Spacers: www.apsonline.com/#sle.
- C. Underground Warning Tape: Polyethylene tape suitable for direct burial.
 - 1. Manufacturers:
 - a. Brady Corporation: www.bradyid.com/#sle.
 - b. Brimar Industries, Inc: www.brimar.com/#sle.
 - c. Seton Identification Products: www.seton.com/#sle.
 - 2. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.
 - 3. Legend: Type of service, continuously repeated over full length of tape.
 - 4. Color:
 - a. Tape for Buried Power Lines: Black text on red background.
 - b. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.04 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Precast Manholes: Inspect in accordance with ASTM C1037.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify routing and termination locations of duct bank prior to excavation for rough-in.

- C. Verify locations of manholes prior to excavating for installation.
- D. Duct bank routing is shown in approximate locations unless dimensions are indicated. Route as required to complete duct system.
- E. Manhole locations are shown in approximate locations unless dimensions are indicated. Locate as required to complete ductbank system.

3.02 DUCT BANK INSTALLATION

- A. Install duct to locate top of ductbank at depths as indicated on drawings.
- B. Install power and communications duct to locate top of ductbank minimum 30 inches below finished grade.
- C. Install duct with minimum slope of 4 inches per 100 feet (0.33 percent). Slope duct away from building entrances.
- D. Cut duct square using saw or pipe cutter; de-burr cut ends.
- E. Insert duct to shoulder of fittings; fasten securely.
- F. Join nonmetallic duct using adhesive as recommended by manufacturer.
- G. Wipe nonmetallic duct dry and clean before joining. Apply full even coat of adhesive to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- H. Install no more than equivalent of three 90-degree bends between pull points.
- I. Provide suitable fittings to accommodate expansion and deflection where required.
- J. Terminate duct at manhole entries using end bell.
- K. Stagger duct joints vertically in concrete encasement 6 inches minimum.
- L. Use suitable separators and chairs installed not greater than 4 feet on centers.
- M. Band ducts together before backfilling.
- N. Securely anchor duct to prevent movement during concrete placement.
- O. Place concrete under provisions of Section 03 30 00. Use mineral pigment to color concrete red.
- P. Provide minimum 3 inch concrete cover at bottom, top, and sides of ductbank.
- Q. Provide two No. 4 steel reinforcing bars in top of bank under paved areas.
- R. Connect to existing concrete encasement using dowels.
- S. Connect to manhole wall using dowels.
- T. Provide suitable pull string in each empty duct except sleeves and nipples.
- U. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.
- V. Interface installation of underground warning tape with backfilling. Install tape 6 inches below finished surface.

3.03 PRE-CAST MANHOLE INSTALLATION

- A. Excavate for manhole installation under the provisions of Section 31 23 16.
- B. Install and seal precast sections in accordance with ASTM C891.
- C. Install manholes plumb.
- D. Use precast neck and shaft sections to bring manhole cover to finished elevation.
- E. Attach cable racks to inserts after manhole installation is complete.
- F. Install drains in manholes and connect to site drainage system under provisions of Section 22 10 06.
- G. Install drains in manholes and connect to 4 inch pipe terminating in 1/3 cu yd crushed gravel bed under provisions of Section 22 10 06.

- H. Dampproof exterior surfaces, joints, and interruptions of manholes after concrete has cured 28 days, under provisions of Section 07 11 13.
- I. Backfill manhole excavation under the provisions of Section 31 23 23.

END OF SECTION

**SECTION 41 22 13.13
BRIDGE CRANE****PART 1 GENERAL****1.01 SUMMARY**

- A. This section includes the following:
 - 1. The work specified in this Section includes furnishing, installing, and testing one overhead bridge crane complete with runways, hoist, trolley, controls, and electrification at the location shown on the Contract Drawings. Included is all wiring, conduit, and switching required for connecting the equipment to the building utilities, and to interconnect the various system components.
- B. Related Sections:
 - 1. Equipment suppliers and installers shall familiarize themselves with the requirements of these sections and incorporate applicable provisions into their work. Cooperate with other trades to facilitate execution of the work.
 - a. Division 01 – General Requirements
 - b. Section 05 50 00 – Metal Fabrications
 - c. Section 11 05 00 – Common Work Results for Shop Equipment
 - d. Division 26 – Electrical

1.02 REFERENCE STANDARDS

- A. The standards and codes listed below form a part of this Section to the extent referenced. The publications are referred to within the text by the basic definition only. The revision in effect at the time of bid opening shall take effect.
 - 1. American Institute of Steel Construction (AISC)
 - 2. American National Standards Institute (ANSI)
 - 3. American Society of Mechanical Engineers (ASME):
 - a. ASME B30.10, Hooks
 - b. ASME B30.17, Cranes and Monorails (With Underhung Trolley or Bridge)
 - c. ASME N30.18, Stacker Cranes (Top or Under Running Bridge, Multiple Girder with Top or Under Running Trolley Hoist)
 - d. ASME B30.20, Below-the-Hook Lifting Devices
 - 4. American Society of Testing Materials (ASTM)
 - 5. American Welding Society (AWS)
 - 6. Crane Manufacturer's Association of America (CMAA):
 - a. CMAA 74, Specification for Top Running and Under Running Single Girder Electric Overhead Cranes Utilizing Under Running Trolley Hoist
 - 7. Hoist Manufacturer's Institute (HMI)
 - 8. National Electric Manufacturers Association (NEMA)
 - 9. National Fire Protection Association (NFPA):
 - a. NFPA 70, National Electric Code
 - 10. Comply with all applicable Federal and State regulatory requirements and with local codes having jurisdiction including, but not limited to:
 - a. Occupational Safety and Health Administration (OSHA)
 - b. Building Code of the State of Pennsylvania and the International Building Code (IBC) as adopted therein.

1.03 SUBMITTALS

- A. Submittals shall cover all equipment listed in this section. The following shall be submitted for review and approval:
 - 1. Shop drawings
 - 2. Operations and maintenance manuals

3. Product data
 4. Installation Instructions
 5. Spare parts list
 6. Structural calculations
 7. Certificate of compliance
 8. Acceptance test program
 9. Warranty
- B. Shop Drawings: Shop drawings shall consist of the following as applicable:
1. Layout drawings showing equipment layout, elevations, conduit runs, utility connections and all required dimensions.
 2. Detail drawings
 3. Structural support drawings and elevation
 4. Utility connection plan
 5. Electrical control diagram
- C. Operation and Maintenance Manuals: Operation and Maintenance Manuals must comply with the requirements of Division 01 and Section 11 05 00 - Common Work Results for Shop Equipment.
- D. Product Data: Manufacturer's literature including catalog cuts, pamphlets, descriptive literature, equipment specifications, performance and test data, and brochures which adequately describe the piece of equipment or product. Catalog cuts shall identify the specified models with highlights or underlines. No generic information will be accepted. Provide sufficient product and preventive maintenance information to properly address each equipment item and all major components installed to the maximum extent possible during the equipment submittal and approval phase of the project.
- E. Installation Instructions: Manufacturer's recommended installation instructions and manufacturer's installation drawings.
- F. Spare Parts List:
1. Submit recommendations for spare parts inventory including types and quantities considered normal for routine maintenance of the equipment for one year.
 2. Submit recommendations for spare parts inventory for approval by the Owner. Spare parts inventory must include types and quantities considered critical for which extended acquisition time would create excessive downtime.
- G. Manufacturer's structural calculations for equipment anchoring requirements shall be prepared in accordance with the International Building Code Seismic Zone for project location. These calculations shall be stamped and signed by a registered Professional Engineer (Civil or Structural) in the State of Pennsylvania.
- H. Contractor's certificate of compliance shall certify that proposed equipment meets or exceeds Specification requirements submitted with Shop Drawings.
- I. Acceptance test program including field testing procedures shall be submitted a minimum of 30 calendar days prior to installation and testing.
- J. Warranty that complies with the Contract Terms and Conditions.

1.04 QUALITY ASSURANCE

- A. Refer to Division 01 and comply with all provisions of Section 11 05 00 - Common Work Results for Shop Equipment.
- B. Qualifications of Manufacturer:
1. The bridge crane and hoist shall be designed, manufactured, assembled and shop tested by a single manufacturer in strict accordance with CMAA and HMI standards.
 2. Manufacturer shall be a reputable manufacturing firm regularly engaged in the design and manufacture of specified equipment. A minimum of five years' experience supplying similar equipment is required.

3. Provide a qualified representative on site to supervise work related to equipment installation, check out, start up, and to provide training.
- C. Qualifications of Installers:
 1. Installation of the work of this Section shall be carried out under the direction of a qualified supervisor who is thoroughly experienced and trained in the pertinent crafts, and who shall be present at the site to direct the installation work.
- D. Field Quality Control
 1. Submit the name and qualifications of testing agencies used in the equipment testing and documentation process to the Owner for approval.
- E. Registration of Designer(s)
 1. Shop drawings and design calculations that pertain to the equipment to be provided under the work of this Section shall be reviewed and sealed by a Professional Engineer, or otherwise professional qualified, to practice in the state or region of manufacture.

1.05 DELIVERABLES

- A. Final Operations and Maintenance Manuals:
 1. Provide Operations and Maintenance Manuals in accordance with the requirements of Division 01 and Section 11 05 00 - Common Work Results for Shop Equipment.
- B. As-Built Drawings in accordance with the requirements of the Contract.
- C. Training Program:
 1. The bridge crane system manufacturer shall provide training on installed equipment. The training program must comply with the requirements of Division 01 and Section 11 05 00 - Common Work Results for Shop Equipment. The training program shall consist of hands-on instruction.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Products shall be delivered, stored and handled in compliance with the requirements specified in Section 11 05 00 - Common Work Results for Shop Equipment and the requirements of the Owner.
- B. Methods for product delivery, storage and handling shall include the following:
 1. Receive, unload, check, protect, and store equipment in facilities suitable to keep it clean, dry, and free from damage, vandalism, and pilferage.
 2. Pay demurrage charges and claims for damage resulting from unloading operations.
 3. Examine equipment for visible and concealed damage. Report any damage to carrier, supplier, and the Owner as soon as possible.
- C. Equipment shall be protected from loss, deterioration, and damage until work is complete. Protection methods shall include the following:
 1. Protect installed equipment prior to start-up and Final Acceptance.
 2. Protect exposed finished surfaces with removable coating or film, cover openings to exclude dirt and fouling materials, and protect unfinished surfaces against rust, corrosion, and other damage.
 3. Protect equipment from paint or coating spills and spots.

1.07 WARRANTY

- A. Provide warranty certificates for all products covering against defects in materials and workmanship, in accordance with the Terms and Conditions, Division 01 and Section 11 05 00 - Common Work Results for Shop Equipment. Any manufacturer's standard warranty that exceeds the length indicated in the Terms and Conditions shall be supplied to the Owner at no additional expense and honored.
- B. Warrant work specified herein for a minimum of one year from date of acceptance against defects in materials, function, and workmanship.
- C. Warranty shall include materials and labor necessary to correct defects.

- D. Defects shall include, but not be limited to, rough or substandard operation, loose, damaged, and missing parts, and abnormal deterioration of finish.

1.08 BASIS OF DESIGN AND ACCEPTABLE MANUFACTURERS

- A. Where a specific manufacturer or product is identified as the Basis of Design or listed first in a list of acceptable manufacturers, the overall project design is based on the identified manufacturer or product. If the Contractor elects to utilize a manufacturer or product which differs from the identified Basis of Design, the Contractor shall bear all efforts and costs of any design changes necessary in order to achieve finished work which is equal in character, performance, and quality to the original design depicted in the Contract Documents. Such changes shall include, but not necessarily be limited to: changes to ratings and/or features of other equipment, changes to material sizes and/or types, new material and/or equipment, and changes to structural and/or architectural features (including room sizes). Approval by the Architect of a proposed item shall not relieve the Contractor of this responsibility.
- B. The listing of specific manufacturers is solely intended to identify reputable manufacturers who are known to provide quality products of the general type specified. Such listing is in no way intended to imply that the identified manufacturer's product(s) have been verified to satisfy the specified requirements, or to be equivalent to any identified Basis of Design manufacturer. Nor does such a listing imply acceptance of products which do not meet the specified requirements, ratings, features, dimensions, and functions as indicated.

PART 2 PRODUCTS

2.01 BRIDGE CRANE WITH HOIST, 2 TON

- A. Equipment Item Number: BC-1
- B. Acceptable Manufacturers:
 - 1. Products of the following manufacturer are specified as the basis of design for the Bridge Crane With Hoist, 2 Ton.
 - a. Konecranes
4401 Gateway Blvd
Springfield, OH 45502
Telephone: 937-525-5533
Model: Top Running Single Girder, 2 Ton Bridge Crane
 - 2. Products of equal quality and utility of other manufacturers will be accepted.
 - a. Sissco Material Handling Equipment
190 Route 206 South
Hillsborough, NJ 08844
Telephone: 908-359-9767
 - b. Or approved equal.
- C. Design Criteria
 - 1. Provide a top running, motorized overhead bridge crane with motorized under-running trolley and wire rope hoist. Crane shall be supplied complete with all components and appurtenances required for proper operation, including, but not limited to hoist, trolley, rails, conductors, festoons, end stops, bumpers, controls, wiring and control pendant.
 - 2. Refer to Contract Drawings for individual bridge crane area of operation.
 - 3. All bridge crane components shall be designed in compliance with CMAA 74 with a minimum service classification of Class B.
 - 4. Hoist and trolleys shall be designed to withstand all stresses imposed under safe operation conditions while handling loads within the rated capacity. Load bearing parts shall be designed such that the static stress, calculated for rated load, shall not exceed 20% of the ultimate strength of the material.
 - 5. Maximum noise shall not exceed 85 dba; sound pressure level measured 20 feet from the noise source.

6. The bridge, hoist and trolley shall be pendant controlled. The trolley shall be motorized.
 7. System shall consist of the following primary components of the bridge crane system, but not be limited to, the following:
 - a. Runway Track
 - b. Bridge girders
 - c. Motorized trolley
 - d. Motorized drives
 - e. Runway electrification
 - f. End stops
 - g. End trucks
 - h. Motorized Hoist
- D. Construction Features of the Bridge:
1. Capacity: 2 Ton
 2. The bridge crane shall be designed to operate within the envelope as indicated on the Contract Drawings.
 3. Girder: Girders shall be standard wide flange structural shape. The crane manufacturer shall select the girder for maximum live load capacity with minimum dead weight, and design the girder to resist all vertical, horizontal, and torsional forces imposed by the hoist and crane movement. The girder shall be sized such that the use of a capping channel section is not required. The girder shall be designed in accordance with the allowable stress and deflection criteria specified by CMAA 74.
 4. End Trucks: End trucks shall be constructed of structural steel providing a rigid structure with sufficient strength to prevent distortion, maintain alignment and distribute wheel loads uniformly under maximum rated load. The minimum end truck wheelbase shall be 1/8 of crane span. One wheel on each end truck shall be driven by a bridge motor. Design shall allow easy wheel removal and exchange. Rail sweeps shall be provided in front of each outside wheel and project below the top of the runway rail. End trucks shall be fitted with shock absorbing bumpers capable of decelerating and stopping the crane within the limits stated by CMAA and OSHA. In the case of axle failure, the end trucks shall not drop by more than one inch.
 5. Bridge crane brakes shall be provided that meet the capacity requirements specified by CMAA 74.
 6. End Truck Wheels: Wheels shall be solid forged steel, designed to carry the wheel loads without undue wear. The wheels shall be hardened to a minimum 260 BNH to ensure their long operating life. The drive wheels shall be driven by a fully splined shaft for uniform rotational force distribution. Wheels shall be supported on fixed axles by anti-friction lifetime lubricated bearings with a maximum L10 life as required by crane service classification.
- E. Motorized Trolley Features and Construction:
1. Frame: The trolley frame shall be a weldment of structural steels.
 2. Wheels: Wheels shall be high strength forged or machined steel, designed to carry the wheel loads without undue wear. The wheels shall be hardened to ensure their long operating life. The wheel tread shall be accurately machined to assure concentricity of axle and tread. Wheels shall be supported on fixed axles by anti-friction lifetime lubricated bearings as required by crane classification.
- F. Hoist Features and Construction:
1. A wire rope hoist shall be provided that is designed to operate on the bridge crane specified herein.
 2. Hoist shall be powered by a single electric motor through a gear train integral with the hoist. The hoist shall be complete and shall include two independent braking systems, load block, hook and wire rope.
 3. Hoist motor shall be a TEFC type with motor insulation Class F and include a thermal overload protection feature.

4. The hoist shall be equipped with a hoist motor brake and a second suitable method of electrical or mechanical braking. Both brakes shall act independently, and each shall be capable of preventing a load from free-falling. The motor brake shall be a direct acting disc type using a short stroke magnet. The torque rating of the motor brake shall not be less than 125% of the full load torque rating of the hoist motor and shall quickly set and stop the motor when the power is interrupted.
 5. The braking system shall under normal operating conditions with a rated load, to stop and hold the load when controls are released. Controlled lowering shall be limited to 120% of rated lowering speed. In the event of complete power failure, the load shall be stopped and held.
 6. Hoist shall be equipped with an overload limiting clutch that permits lifting loads within its rated capacity and prevents lifting excessive loads that could damage the hoist.
 7. Hoist shall incorporate both upper and lower limit switches that automatically stop the hoist motion when the block reaches the extent of travel. The limit switches shall be adjustable.
 8. Hoist Basis of Design: Konecranes 2 Ton, Wire Rope Model #: CXT40210020A3
- G. Hook
1. Hook shall be drop forged, heat-treated alloy steel in accordance with ANSI/ASME B30.10.
 2. Hook shall be able to swivel freely and shall be retained by positively secured nuts which will prevent hooks from working loose.
 3. Hook shall be equipped with a spring type latch to close the throat opening.
- H. Controls
1. Crane controls shall comply with National Electrical Code requirements for the application being considered and shall include control circuit fusing and contactors mechanically and electrically interlocked.
 2. Panels shall be coated with white enamel, so all components and wiring are clearly visible for servicing.
 3. Control enclosures shall be made of sheet steel and meet NEMA 4 standards. All external wiring shall enter the enclosure behind the panel. All control wiring shall be color coded based on function and tagged at each end.
 4. Control panels shall include mainline fusing to protect the crane from short circuits. All motors shall be fuse protected to provide overcurrent and short circuit protection in all three phases.
 5. All motor starters shall be adequately sized for crane duty consistent with horsepower requirements.
- I. Pendant Control
1. The primary control of all functions shall be with a pendant pushbutton station.
 2. Pendant station enclosure shall be impact resistant and shall consist of push buttons arranged to meet CMAA specifications with separate buttons for auxiliary functions.
 3. Pendant cord shall consist of extra flexible multi-conductor cable with internal strain relief. The individual wires are to be stranded within a lead cured, neoprene jacket. The pendant control cable shall be furnished with a polarized quick disconnect connector.
 4. The pendant shall be festooned to allow operation anywhere along the length of bridge.
- J. Runway Electrification
1. Electrification shall include conductor bars, collectors, power feeds, appropriate mounting hardware and other accessories as recommended by the crane manufacturer. Electrical components shall have Underwriter's Laboratories approval.
 2. The runway conductor and collector system shall be sized and installed in accordance with all applicable codes and the specifications listed in Article 1.02 of this Section.
 3. Conductors are to be complete with mounting brackets, insulators, couplings, end caps and current taps.
- K. Runway Beam and End-Stops:

1. Crane runway shall be designed in accordance with CMAA 74 and fabricated in accordance with AISC specifications. Runway rails shall be standard rail sections, or other commercial rolled section with equivalent specifications, and of a proper size for the crane to be installed. The runway rail tolerances shall meet the tolerance criteria specified by CMAA 74. No rough-cut ends will be permitted. Holes shall be factory punched or drilled. All welds shall be full penetration. The runways shall be coated with a minimum of one coat of primer and a protective topcoat.
 2. Provide bridge girder end stops at both sides of the runways. See Contract Drawings for details on stop locations. The end stops shall be designed to withstand the loads that would develop under the bridge bumper design criteria specified by CMAA 74. Install end stops as close as possible to end of the runway rail to maximize bridge travel.
- L. Capacities and Dimensions:
1. Crane Bridge:
 - a. Capacity: 2 Ton.
 - b. Span: Approximately 56 feet – 9 inches. Crane span shall be verified with building structure prior to fabrication.
 - c. Length: Approximately 58 feet – 6 inches.
 - d. Hook Height Minimum in Raised Position: 35 feet.
 - e. Bridge Travel Speed: Stepless Variable Frequency Drive (VFD) maximum of 100 FPM
 - f. Bridge Motor: Quantity two each 0.5 hp
 - g. Runway Rail Type: ASCE30
 - h. Bridge / Girder Depth: approximately 24 inches
 - i. Maximum Static Wheel Loads: 4.2 kips
 - j. Maximum Dynamic Wheel Loads (with 125% impact factor): 5.2 kips
 2. Trolley/Hoist:
 - a. Capacity: 2 Ton
 - b. Hoist Lift Speed: Stepless VFD, Maximum 24 FPM, Minimum 2.4 FPM
 - c. Hoist Motor Horsepower: 3.6 HP
 - d. Hoist lift (minimum): 35 feet
 - e. Pendant Drop: A minimum of 3 feet from the floor, approximately 32 feet from underside of bridge
 - f. Trolley Speed: Stepless VFD maximum of 65 FPM
 - g. Trolley Motor: 0.7 hp
- M. Electrical Requirements:
1. The crane control, protective devices and safety features shall be designed and installed in accordance with CMAA 74, unless otherwise specified.
 2. The bridge and trolley shall have variable frequency controls in all directions and provide for accurate spotting. The controls shall be reversing with under voltage and overload protection.
 3. Power Supply:
 - a. Bridge Crane: 460 volts, 3 phase, 60 Hz with 100A power bar for runway.
 - b. Trolley: 460 volts, 3 phase, 60 Hz
 - c. Hoist: 460 V, 3 Phase, 60 Hz, 115V Control. Starting Current 15A.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Contractor shall comply with the Site Examination requirements specified in Section 11 05 00 - Common Work Results for Shop Equipment and in this Section.
- B. Verification of Conditions: Contractor shall verify that field measurements, surfaces, substrates, and conditions are as required, and ready to receive Work.

- C. Contractor shall examine areas, equipment foundations, and conditions with Installer present for compliance with requirements for installation and other conditions affecting performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.
- D. Contractor shall examine roughing-in of electrical systems to verify actual locations of utility connections prior to equipment installation.

3.02 PREPARATION

- A. Contractor shall comply with the Preparation requirements specified in Section 11 05 00 - Common Work Results for Shop Equipment.

3.03 INSTALLATION

- A. Contractor shall comply with the installation requirements specified in Section 11 05 00 - Common Work Results for Shop Equipment and in this Section.
- B. Install equipment and all specified appurtenances and accessories in strict accordance with the approved shop drawings and manufacturer's installation instructions.
- C. Contractor shall be responsible for coordinating with the manufacturer regarding the scheduling, delivery, and preparations necessary to install the specified equipment.
- D. All marred or damaged surfaces shall be touched up or refinished to leave a smooth, uniform finish at the time of final inspection.
- E. All loose materials, crating and packing materials shall be removed from site premises.

3.04 INSPECTION

- A. Representatives of the Owner shall have the right of inspection of equipment Manufacturer's facilities in accordance with the Contract Terms and Conditions.

3.05 FACTORY AND FIELD TESTS:

- A. Factory Test
 - 1. The Contractor shall arrange with the equipment manufacturer for the performance of a simulation test as applicable to ensure equipment is fully functional prior to shipment. These tests shall be performed at the factory and shall be performed prior to final painting of the equipment.
- B. Field Test
 - 1. Testing of the equipment and system shall be performed in accordance with the requirements specified in the General Provisions and Section 11 05 00 - Common Work Results for Shop Equipment. Perform and document all testing procedures in accordance with the manufacturer's recommendations, OSHA standards, ANSI B30.10 and ANSI B30.20.
- C. Test the crane for operation and load test at not less than 100 percent and not more than 125 percent of the rated load.
- D. Testing to be performed by a qualified Inspection and Test Agency.

3.06 FIELD QUALITY CONTROL:

- A. Provide the services of a qualified manufacturer's representative to perform the following:
 - 1. Supervise preparatory work performed by other trades.
 - 2. Supervise installation.
 - 3. Supervise testing, by the Contractor, in the presence of the Owner, prior to substantial completion of the facility to ensure proper operation of the equipment.

3.07 TRAINING PROGRAM AND OPERATION AND MAINTENANCE MANUALS

- A. Provide a training program and operation and maintenance manuals in accordance with the requirements specified in Division 01 and Section 11 05 00 - Common Work Results for Shop Equipment.

- B. Operations and Maintenance Manuals shall be approved and accepted prior to the training and will be provided as required for reference materials during class presentations.

END OF SECTION